



CCGPS Frameworks Student Edition

Mathematics

**Fifth Grade Unit Four
Adding, Subtracting, Multiplying, and
Dividing Fractions**



Dr. John D. Barge, State School Superintendent
"Making Education Work for All Georgians"

Unit 4: Adding, Subtracting, Multiplying, and Dividing Fractions

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OVERVIEW

In this unit, students will:

engage in the following standard clusters to make sense of, and compute with, fractions in way that builds on their own understandings of fractions.

use equivalent fractions as a strategy to add and subtract fractions.

apply and extend previous understandings of multiplication and division to multiply and divide fractions.

It is important that students are eventually able use an algorithm to compute with fractions. However, building understanding through the use of manipulatives, mathematical representations, and student discourse while students develop these algorithms through problem solving tasks is research-based best practice. (Huinker, 1998)

The following guidelines should be kept in mind when developing computational strategies with children (Elementary and Middle School Mathematics, Teaching Developmentally, Van de Walle, John A., Karp, Karen S., and Bay-Williams, Jennifer M. 2010, Pearson Ed. Inc., pg 310).

1. *Begin with simple, contextual tasks.* What you want is a context for both the meaning of the operation and the fractions involved.
2. *Connect the meaning of fraction computation with whole-number computation.* To consider what $2\frac{1}{2} \times \frac{3}{4}$ might mean, we should ask, “What does 2×3 mean?” Follow this with “What does $2 \times 3\frac{1}{2}$ mean?” slowly moving to a fraction times a fraction.
3. *Let estimation and informal methods play a big role in the development of strategies.* “Should $2\frac{1}{2} \times \frac{1}{4}$ be more or less than 1? More or less than 2?” Estimation keeps the focus on the meanings of the numbers and the operations, encourages reflective thinking, and helps build informal number sense with fractions.
4. *Explore each of the operations using models.* Use a variety of models. Have students defend their solutions using the models, including simple student drawings. Sometimes it may happen that you get answers with models that do not seem to help with pencil and paper methods. This is fine! The ideas will help students learn to think about fractions and the operations, contribute to mental methods, and provide a useful background when you do get to the standard algorithms.

Mathematically proficient students communicate precisely by engaging in discussion about their reasoning using appropriate mathematical language. The terms students should learn to use with increasing precision with this cluster are: **fraction, equivalent, addition/ add, sum, subtraction/subtract, difference, unlike denominator, numerator, benchmark fraction, estimate, reasonableness, and mixed numbers**

The Critical Areas are designed to bring focus to the standards at each grade by describing

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the big ideas that educators can use to build their curriculum and to guide instruction.

1. Developing fluency with addition and subtraction of fractions, and developing understanding of the multiplication of fractions and of division of fractions in limited cases (unit fractions divided by whole numbers and whole numbers divided by unit fractions)

Students apply their understanding of fractions and fraction models to represent the addition and subtraction of fractions with unlike denominators as equivalent calculations with like denominators. They develop fluency in calculating sums and differences of fractions, and make reasonable estimates of them. Students also use the meaning of fractions, of multiplication and division, and the relationship between multiplication and division to understand and explain why the procedures for multiplying and dividing fractions make sense. (Note: this is limited to the case of dividing unit fractions by whole numbers and whole numbers by unit fractions.)

2. Extending division to 2-digit divisors, integrating decimal fractions into the place value system and developing understanding of operations with decimals to hundredths, and developing fluency with whole number and decimal operations

Students develop understanding of why division procedures work based on the meaning of base-ten numerals and properties of operations. They finalize fluency with multi-digit addition, subtraction, multiplication, and division. They apply their understandings of models for decimals, decimal notation, and properties of operations to add and subtract decimals to hundredths. They develop fluency in these computations, and make reasonable estimates of their results. Students use the relationship between decimals and fractions, as well as the relationship between finite decimals and whole numbers (i.e., a finite decimal multiplied by an appropriate power of 10 is a whole number), to understand and explain why the procedures for multiplying and dividing finite decimals make sense. They compute products and quotients of decimals to hundredths efficiently and accurately.

Mentor texts that may be useful for teaching this unit are listed below.

My Half Day by Doris Fisher

Ed Emberly's Picture Pie by Ed Emberley

Two Ways to Count to ten by Ruby Dee

My Even Day by Doris Fisher

The Wishing Club: A story about fractions by Donna Jo Naoli

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators.

For example, $\frac{2}{3} + \frac{5}{4} = \frac{8}{12} + \frac{15}{12} = \frac{23}{12}$. (In general, $\frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd}$.)

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MCC5.NF.2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers.

For example, recognize an incorrect result $2/5 + 1/2 = 3/7$, by observing that $3/7 < 1/2$.

MCC5.NF.3 Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem.

For example, interpret $3/4$ as the result of dividing 3 by 4, noting that $3/4$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size $3/4$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?

MCC5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$.

For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)

b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.

MCC5.NF.5 Interpret multiplication as scaling (resizing), by:

a. Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.

b. Explaining why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence $a/b = (n \times a)/(n \times b)$ to the effect of multiplying a/b by 1.

MCC5.NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.

MCC5.NF.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.¹

a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients.

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For example, create a story context for $(1/3) \div 4$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $(1/3) \div 4 = 1/12$ because $(1/12) \times 4 = 1/3$.

¹ Students able to multiply fractions in general can develop strategies to divide fractions in general, by reasoning about the relationship between multiplication and division. But division of a fraction by a fraction is not a requirement at this grade.

STANDARDS FOR MATHEMATICAL PRACTICE

Students are expected to:

- 1. Make sense of problems and persevere in solving them.**
- 2. Reason abstractly and quantitatively.**
- 3. Construct viable arguments and critique the reasoning of others.**
- 4. Model with mathematics.**
- 5. Use appropriate tools strategically.**
- 6. Attend to precision.**
- 7. Look for and make use of structure.**
- 8. Look for and express regularity in repeated reasoning.**

*****Mathematical Practices 1 and 6 should be evident in EVERY lesson*****

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important “processes and proficiencies” with longstanding importance in mathematics education.

The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections.

The second are the strands of mathematical proficiency specified in the National Research Council’s report *Adding It Up*: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy).

ENDURING UNDERSTANDINGS

- A fraction is another representation for division.
- Fractions are relations – the size or amount of the whole matters.
- Fractions may represent division with a quotient less than one.
- Equivalent fractions represent the same value.
- With unit fractions, the greater the denominator, the smaller the piece is.
- Pieces don’t have to be congruent to be equivalent.

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- Fractions and decimals are different representations for the same amounts and can be used interchangeably.

ESSENTIAL QUESTIONS

- How are equivalent fractions helpful when solving problems?
- How can a fraction be greater than 1?
- How can a model help us make sense of a problem?
- How can comparing factor size to 1 help us predict what will happen to the product?
- How can decomposing fractions or mixed numbers help us model fraction multiplication?
- How can decomposing fractions or mixed numbers help us multiply fractions?
- How can fractions be used to describe fair shares?
- How can fractions with different denominators be added together?
- How can looking at patterns help us find equivalent fractions?
- How can making equivalent fractions and using models help us solve problems?
- How can modeling an area help us with multiplying fractions?
- How can we describe how much someone gets in a fair-share situation if the fair share is less than 1?
- How can we describe how much someone gets in a fair-share situation if the fair share is between two whole numbers?
- How can we model an area with fractional pieces?
- How can we model dividing a unit fraction by a whole number with manipulatives and diagrams?
- How can we tell if a fraction is greater than, less than, or equal to one whole?
- How does the size of the whole determine the size of the fraction?
- What connections can we make between the models and equations with fractions?
- What do equivalent fractions have to do with adding and subtracting fractions?
- What does dividing a unit fraction by a whole number look like?
- What does dividing a whole number by a unit fraction look like?
- What does it mean to decompose fractions or mixed numbers?
- What models can we use to help us add and subtract fractions with different denominators?
- What strategies can we use for adding and subtracting fractions with different denominators?
- When should we use models to solve problems with fractions?
- Why is it important to know how close a fraction is to one whole?

SELECTED TERMS AND SYMBOLS

The following terms and symbols are often misunderstood. These concepts are not an inclusive list and should not be taught in isolation. However, due to evidence of frequent difficulty and misunderstanding associated with these concepts, instructors should pay particular attention to them and how their students are able to explain and apply them.

The terms below are for teacher reference only and are not to be memorized by students.

Teachers should first present these concepts to students with models and real life examples. Students should understand the concepts involved and be able to recognize and/or use them with words, models, pictures, or numbers.

- **simplify**
- **common denominator**
- **unlike denominator**
- **numerator**
- **improper fraction**
- **mixed number**
- **unit fraction**
- **equivalent**
- **reasonableness**
- **estimate**
- **benchmark fraction**
- **addition/add**
- **subtraction/subtract**
- **difference**

STRATEGIES FOR TEACHING AND LEARNING *Adapted from the Ohio DOE*

To add or subtract fractions with unlike denominators, students use their understanding of equivalent fractions to create fractions with the same denominators. Start with problems that require the changing of one of the fractions and progress to changing both fractions. Allow students to add and subtract fractions using different strategies such as number lines, area models, fraction bars or strips. Have students share their strategies and discuss commonalities in them.

Students need to develop the understanding that when adding or subtracting fractions, the fractions must refer to the same whole. Any models used must refer to the same whole. Students may find that a circular model might not be the best model when adding or subtracting fractions.

As with solving word problems with whole number operations, regularly present word problems involving addition or subtraction of fractions. The concept of adding or subtracting fractions with unlike denominators will develop through solving problems. Mental computations and estimation strategies should be used to determine the reasonableness of answers. Students need to prove or disprove whether an answer provided for a problem is reasonable.

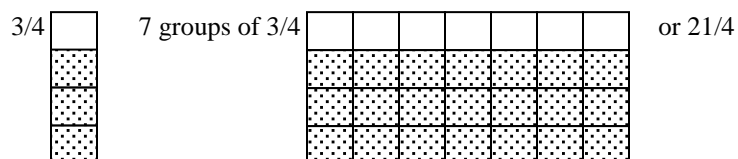
Estimation is about getting useful answers, it is not about getting the right answer. It is important for students to learn which strategy to use for estimation. Students need to think about what might be a close answer.

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Connect the meaning of multiplication and division of fractions with whole-number multiplication and division. Consider area models of multiplication and both sharing and measuring models for division.

Ask questions such as, “What does 2×3 mean?” and “What does $12 \div 3$ mean?” Then, follow with questions for multiplication with fractions, such as, “What does $3/4 \times 1/3$ mean?” “What does $3/4 \times 7$ mean?” (7 sets of $3/4$) and what does $7 \times 3/4$ mean?” ($3/4$ of a set of 7)

The meaning of $4 \div 1/2$ (how many $1/2$ are in 4) and $12 \div 4$ (how many groups of 4 are in 12) also should be illustrated with models or drawings such as:



Encourage students to use models or drawings to multiply or divide with fractions. Begin with students modeling multiplication and division with whole numbers. Have them explain how they used the model or drawing to arrive at the solution.

Models to consider when multiplying or dividing fractions include, but are not limited to: area models using rectangles or squares, fraction strips/bars and sets of counters.

Use calculators or models to explain what happens to the result of multiplying a whole number by a fraction ($3 \times 1/2$, $4 \times 1/2$, $5 \times 1/2$...and $4 \times 1/2$, $4 \times 1/3$, $4 \times 1/4$, ...) and when multiplying a fraction by a number greater than 1.

Use calculators or models to explain what happens to the result when dividing a unit fraction by a non-zero whole number ($1/8 \div 4$, $1/8 \div 8$, $1/8 \div 16$, ...) and what happens to the result when dividing a whole number by a unit fraction ($4 \div 1/4$, $8 \div 1/4$, $12 \div 1/4$, ...).

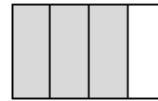
Present problem situations and have students use models and equations to solve the problem. It is important for students to develop understanding of multiplication and division of fractions through contextual situations.

COMMON MISCONCEPTIONS *From the Mathematics Model Curriculum, Ohio, DOE*

Students often mix models when adding, subtracting or comparing fractions. Students will use a circle for thirds and a rectangle for fourths when comparing fractions with thirds and fourths. Remind students that the representations need to be from the same whole models with the same shape and size.



These models of fractions are difficult to compare because the size of the whole is not the same for all representations



These models of fractions use the same size rectangle to represent the whole unit and are therefore much easier to compare fractions.



Students may believe that multiplication always results in a larger number. Using models when multiplying with fractions will enable students to see that the results will be smaller.

Additionally, students may believe that division always results in a smaller number. Using models when dividing with fractions will enable students to see that the results will be larger.

EVIDENCE OF LEARNING

By the conclusion of this unit, students should be able to demonstrate the following competencies:

- Use multiple strategies to find equivalent fractions
- Find equivalent fractions and use them to solve problems
- Simplify fractions
- Use concrete, pictorial, and computational models to find common denominators
- Use fractions (proper and improper) and add and subtract fractions and mixed numbers with unlike denominators to solve problems
- Use concrete, pictorial, and computational models to multiply fractions
- Use concrete, pictorial, and computational models to divide unit fractions by whole number and whole numbers by unit fractions
- Estimate products and quotients

As this unit has no Culminating Task, you may pair/modify tasks to include all unit standards in combination.

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TASKS

Scaffolding Task	Constructing Task	Practice Task	Performance Tasks
Tasks that build up to the constructing task.	Constructing understanding through deep/rich contextualized problem solving tasks	Games/activities	Summative assessment for the unit.

<u>Task Name</u>	<u>Task Type</u> <i>Grouping Strategy</i>	<u>Content Addressed</u>
<u>Equal to One Whole, More or Less</u>	Scaffolding Task <i>Small Group/Partner Task</i>	Determining whether a fraction is Greater, Less, or Equal to 1
<u>Sharing Candy Bars</u>	Constructing Task <i>Small Group/Partner Task</i>	Fractions as Division
<u>Sharing Candy Bars Differently</u>	Constructing Task <i>Small Group/Partner Task</i>	Fractions as Division
<u>Hiking Trail</u>	Constructing Task <i>Individual/Partner Task</i>	Fractions of whole numbers, introducing operations with fractions
<u>Fraction Addition and Subtraction</u>	Constructing Task <i>Individual/Partner Task</i>	Fraction Addition and Subtraction
<u>Flip it Over</u>	Practice Task <i>Partner/Small Group Task</i>	Building Fluency with Addition of Fractions
<u>Up and Down the Number Line</u>	Practice Task <i>Small Group/Partner Task</i>	Building Fluency with Addition and Subtraction of Fractions
<u>Create Three</u>	Practice Task <i>Small Group/Partner Task</i>	Building Fluency with Addition of Fractions
<u>The Wishing Club</u>	Constructing Task <i>Partner/Small Group Task</i>	Fraction Addition
<u>Comparing MP3s</u>	Constructing Task <i>Partner Task</i>	Multiplication of Fractions as an area model
<u>Measuring for a Pillow</u>	Performance Task <i>Individual/Partner Task</i>	Using an area model to multiply and compare products based on factors
<u>Reasoning with Fractions</u>	Constructing Task <i>Individual/Partner Task</i>	Determine the effect on a product, of multiplying a number by a factor greater than 1 and less than 1.
<u>Dividing with Unit Fractions</u>	Constructing Task <i>Partner Task</i>	Investigate dividing whole numbers by unit fractions and unit fractions by whole numbers
<u>Adjusting a Recipe</u>	Performance Task	Multiply, divide, add, and

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Scaffolding Task: Equal to One Whole, More, or Less?

STANDARDS FOR MATHEMATICAL CONTENT

Extend understanding of fraction equivalence and ordering.

MCC5.NF.2. Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as $\frac{1}{2}$. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols $>$, $=$, or $<$, and justify the conclusions, e.g., by using a visual fraction model.

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can we tell if a fraction is greater than, less than, or equal to one whole?
- Why is it important to know how close a fraction is to one whole?
- How can a fraction be greater than 1?

MATERIALS

- Paper
- Pencil
- Accessible manipulatives

GROUPING

Whole/Individual/Small Group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION:

Comments:

Students need to be confident in their understanding of fractions greater than, equal to, and less than one whole. This task builds on understandings from Fourth Grade M3 NF 3. This task was

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adapted from Teaching Student Centered Mathematics, Grades 3-5, Van de Walle, John A. and Lovin, LouAnn H., pg. 138.

A recording sheet is provided, but is not necessary for this task, especially if students are using a math journal or learning log. Students should draw representations of their mathematical thinking as well as use words and numbers to explain their thinking for three reasons:

SMP2. Reason abstractly and quantitatively.

SMP3. Construct viable arguments and critique the reasoning of others.

SMP4. Model with mathematics.

Drawing representations allows students to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

Students engaging in this task must have an understanding of fair shares.

Teacher Notes:

Make sure there are a variety of math manipulatives in the collections students are using. Several templates are included at the end of this task, but any familiar manipulative may be used. For example, place three blue rhombi from a set of pattern blocks in a baggie with a note card that says, “These are fifths.” Students need to decide whether these three fifths are more, less, or equal to one whole. Likewise, place 12 green triangles in a baggie with a card that says, “These are eighths.”

Resist the temptation to only use one type of manipulative for this task, such as pattern blocks. Make some sets with pattern blocks as the fractional parts, some with color tiles, some with Cuisenaire Rods, some with (unlabeled) fraction strips, etc. Stay away from fraction circle pieces, as they are too much of a giveaway.

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answer is correct?
- How far away from a whole is your fraction? How do you know?
- What if we said these pieces you’ve drawn right here were now halves instead of eighths? How would your answer change?
- Did you develop a shortcut to find your answers?
- Did you identify any patterns or rules? Explain!

ENDURING UNDERSTANDINGS

A fraction is another representation for division.

Equivalent fractions represent the same value.

Fractional parts are equal shares or equal-sized portions of a whole or unit (a unit can be an object or a collection of things).

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The more fractional parts used to make a whole, the smaller the parts.

The denominator of a fraction indicates by what number the whole has been divided (The denominator is the divisor).

The numerator of a fraction tells how many of the fractional parts are under consideration (The numerator is the multiplier).

Task:

Students are given a collection of fractional parts (all the same type) and they need to indicate the kind of fractional part they have. The task is to decide if the collection of fractional parts is less than, greater than, or equal to one whole.

DIFFERENTIATION

Extension

- Allow students to tell how close the set is to a complete whole.
- Allow students, who are ready, to create baggies. Students who are ready for this extension consistently identify the fractional parts in a general task above, and justify their thinking in using multiple strategies.

Intervention

- Allow students to work through a task that identifies the pieces as halves, thirds, or fourths. Students may need multiple experiences using different manipulatives. It is important for students to draw diagrams to represent the physical models before moving to a completely abstract algorithm to determine whether a fraction is greater, less, or equal to one whole.

Scaffolding Task: Equal to One Whole, More, or Less?

Using the baggie with fractional parts with the card inside, decide if the collection is less than one whole, equal to one whole, or more than one whole. Do this for at least three different collections of fractional parts. Draw pictures, and/or use numbers to explain your answer.

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These are halves	These are thirds	These are fourths	These are fifths
These are sixths	These are sevenths	These are eighths	These are ninth
These are tenths	These are twelfths	These are sixteenths	These are eighteenths
These are twentieths	These are twenty- fifths	These are fiftieths	These are hundredths

[illegible]

Constructing Task: Sharing Candy Bars

Adapted from Contexts for Learning Mathematics Fractions, Decimals, and Percents by Fosnot, Catherine Twomey et.al.

Children learn mathematics by using what they know to make sense of new mathematical ideas. Equal sharing problems offer students the opportunity to use what they know about partitioning and division to learn fractions.

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.2

Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

3. Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret $3/4$ as the result of dividing 3 by 4, noting that $3/4$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size $3/4$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?*

MCC5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)*

MC5.NF.6. Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

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- How can we describe how much someone gets in a fair-share situation if the fair share is less than 1?
- How can we describe how much someone gets in a fair-share situation if the fair share is between two whole numbers?
- How can fractions be used to describe fair shares?

MATERIALS

- Copy of Sharing Candy Bars task (1 per pair or small group), or blank index cards to represent the candy bars
- Pencil
- Accessible manipulatives

GROUPING

Pair/Small Group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION:

Comments:

This task was developed from *Contexts for Learning Mathematics*, by Fosnot and Jacob. A recording sheet is provided, but is not necessary for this task, especially if students are using a math journal or learning log. Students should draw representations of their mathematical thinking as well as use words and numbers to explain their thinking for three reasons:

SMP2. Reason abstractly and quantitatively.

SMP3. Construct viable arguments and critique the reasoning of others.

SMP4. Model with mathematics.

Students should be allowed to draw representations of their thinking. This allows them to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

Students engaging in this task have an understanding of fair shares. If students lack this understanding, they will benefit from the previous task, as well as activities from Teaching Student Centered Mathematics, by John Van de Walle, pg. 136.

Teacher Notes:

Introduce the problem and be sure everyone is clear with the context. You may wish to use the pictures included at the end of this task to help develop this context.

Facilitate a preliminary discussion with the class, before students get to working on the problem. Allow students to share their initial thoughts, then ask them to work in pairs to investigate the following:

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Was the distribution of candy bars fair – did everyone in the class get the same amount?
How much of a candy bar did each person get, assuming the pieces were cut equally?
Possible struggles students may have can be turned into wonderful inquiries! As students cut up the candy bars, you may notice them:

Cutting each candy bar into a familiar fraction first, such as halves or thirds, then cut the leftovers into slivers. This strategy may cause struggles with what to name the pieces (what is $\frac{1}{5}$ of $\frac{1}{3}$? for example)

Cutting each candy bar into a number of pieces that is the same as the number of people in the group. For example, if 4 candy bars are shared among 5 people, each of the 4 candy bars is cut into 5 pieces. So, $\frac{1}{5}$ of each candy bar goes to each of the 5 people. This may cause students to struggle with the idea that the size of the whole matters. Everyone gets $\frac{4}{20}$ of the pieces, but this is also $\frac{4}{5}$ of one candy bar.

Using the long division algorithm to find a decimal quotient ($4 \div 5 = 0.8$). This strategy may promote discussion, so please allow students the freedom to make sense of this in the closing part of the lesson.

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answer is correct?
- How far away from a whole is your fraction? How do you know?
- What if we said these pieces you've drawn right here were now halves instead of eighths? How would your answer change?
- Did you develop a shortcut to find your answers?
- Did you identify any patterns or rules? Explain!

After enough time has been devoted to the task, ask pairs of students to make posters to prepare for the closing of the lesson. Posters should be clear for others in the class to understand their thinking, but should not just be the figuring that was initially done copied over again. The posters should be clear and concise presentations of any important ideas and strategies students wish to present.

Some ideas to encourage discussion about in the presentations of student work:

- The size or amount of the whole matters
- With unit fractions, the greater the denominator, the smaller the piece is
- When naming the piece, the whole matters

This task is not enough for children to have a full understanding of fractions as division, nor is it enough for students to gain understandings of multiplication, division, or comparing fractions. It is an introduction to the idea of fractions in an equal sharing context, which opens the door for students to grapple with understanding fractions as division. It also allows

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for students to make sense of a real life situation that may promote inquiry into other mathematical ideas with fractions.

Questions for Teacher Reflection

- How did my students engage in the 8 mathematical practices today?
- How effective was I in creating an environment where meaningful learning could take place?
- How effective was my questioning today? Did I question too little or say too much?
- Were manipulatives made accessible for students to work through the task?
- One positive thing about today's lesson and one thing you will change.

The following are instructional guidelines for creating more, perhaps similar equal sharing problems for fifth grade students.

Instructional guidelines for Equal Sharing Problems and Introducing Fractions (from Extending Children's Mathematics, Fractions and Decimals, Empson, Susan B., and Levi, Linda)

- Equal sharing problems with answers that are mixed numbers and fractions less than 1. Focus on problems with 4, 8, 3, 6, 10, and 12 sharers, but include other numbers of sharers as well, such as 15, 20, and 100.
- Represent children's solutions with equations, with an emphasis on linking addition and multiplication and on equations that reflect a multiplicative understanding of fractions. For example, if students solved a problem about 8 children sharing 5 burgers you might write the following equations:
 - $1/8 + 1/8 + 1/8 + 1/8 + 1/8 = 5/8$ ("Lura drew 5 hamburgers and gave each person an eighth of each hamburger. She put the pieces together and said that $1/8$ plus $1/8$ plus $1/8$ plus $1/8$ is $5/8$. Does this equation show what Lura did?)
 - $5 \times 1/8 = 5/8$ ("Shelly drew 1 hamburger and split it into 8 pieces. She said that each person would get $1/8$ of this hamburger. The other hamburgers would look the same as this and she said 5 groups of $1/8$ is the same as $5/8$.")
 - 5 divided by 8 is $5/8$ ("Krystal said that she knows that when 5 things are shared by 8 people, each person gets $5/8$.")
- Represent the word problem situation using equations.
- 8 children are sharing 5 hamburgers equally. How much hamburger does one child get?
 - $5 \div 8 = \square$
 - $8 \times \square = 5$

DIFFERENTIATION

Extension

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- Allow students to investigate other shares and sharers as identified above. To challenge students, especially with large numbers of sharers, insist that students represent their fractions in multiple ways. For example, our team of 100 5th grade students is sharing the challenge of running a 40 mile race for charity. How many miles is each student's responsibility? Students could shade in a 10x10 grid, show the fraction as 40/100 and (0.40), then show it again as 4/10 (0.4) and again as 2/5.

Intervention

- Use smaller numbers of sharers. For example, give students one or two candy bars that have 2-3 sharers. The use of student created or commercial manipulatives, with teacher guidance and questioning will help students develop the concept of fractions as division.

Technology

http://nlvm.usu.edu/en/nav/category_g_2_t_1.html the national library of virtual manipulatives has several activities for students to practice operations and understanding of fractions.

<http://calculationnation.nctm.org/Games/> this site, from NCTM, has engaging and sometimes addictive games for practicing calculations based on strategy.

<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.

Sharing Candy Bars

A fifth grade class is split into four groups. Students in the class brought in candy bars for a fraction celebration. When it was time for the celebration, the candy bars were shared as follows:

- The first group had 4 people and shared 3 candy bars equally.
- The second group had 5 people and shared 4 candy bars equally.
- The third group had 8 people and shared 7 candy bars equally.
- The fourth group had 5 people and shared 3 candy bars equally.

When the celebration was over the children began to argue that the distribution of candy bars was unfair, that some children got more to eat than others. Were they right? Or, did everyone get the same amount?

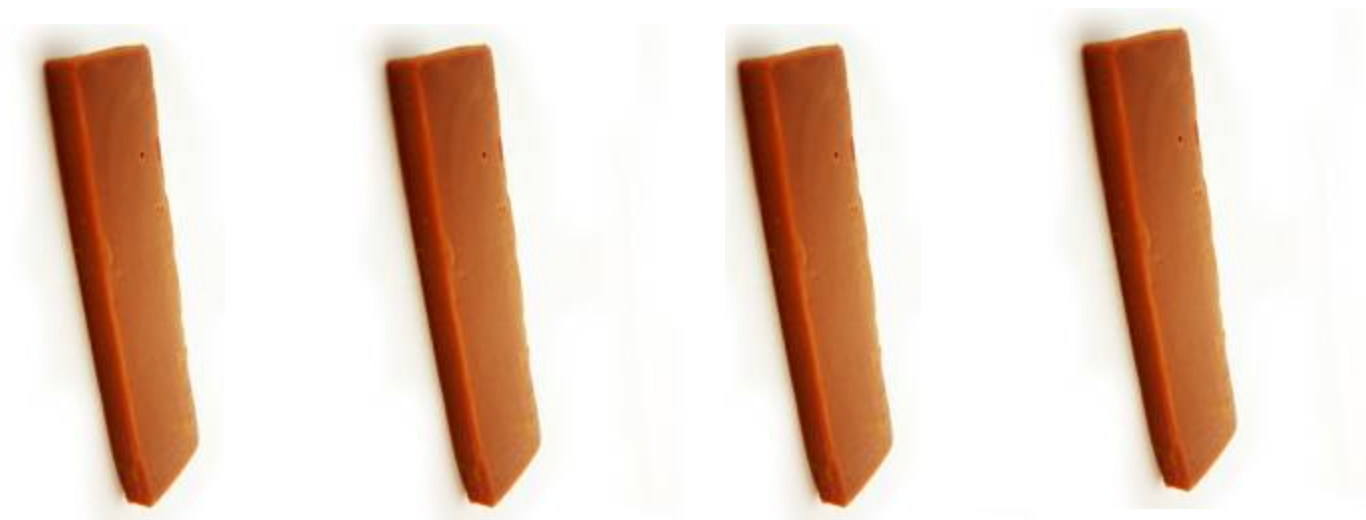
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Four people share these three candy bars.



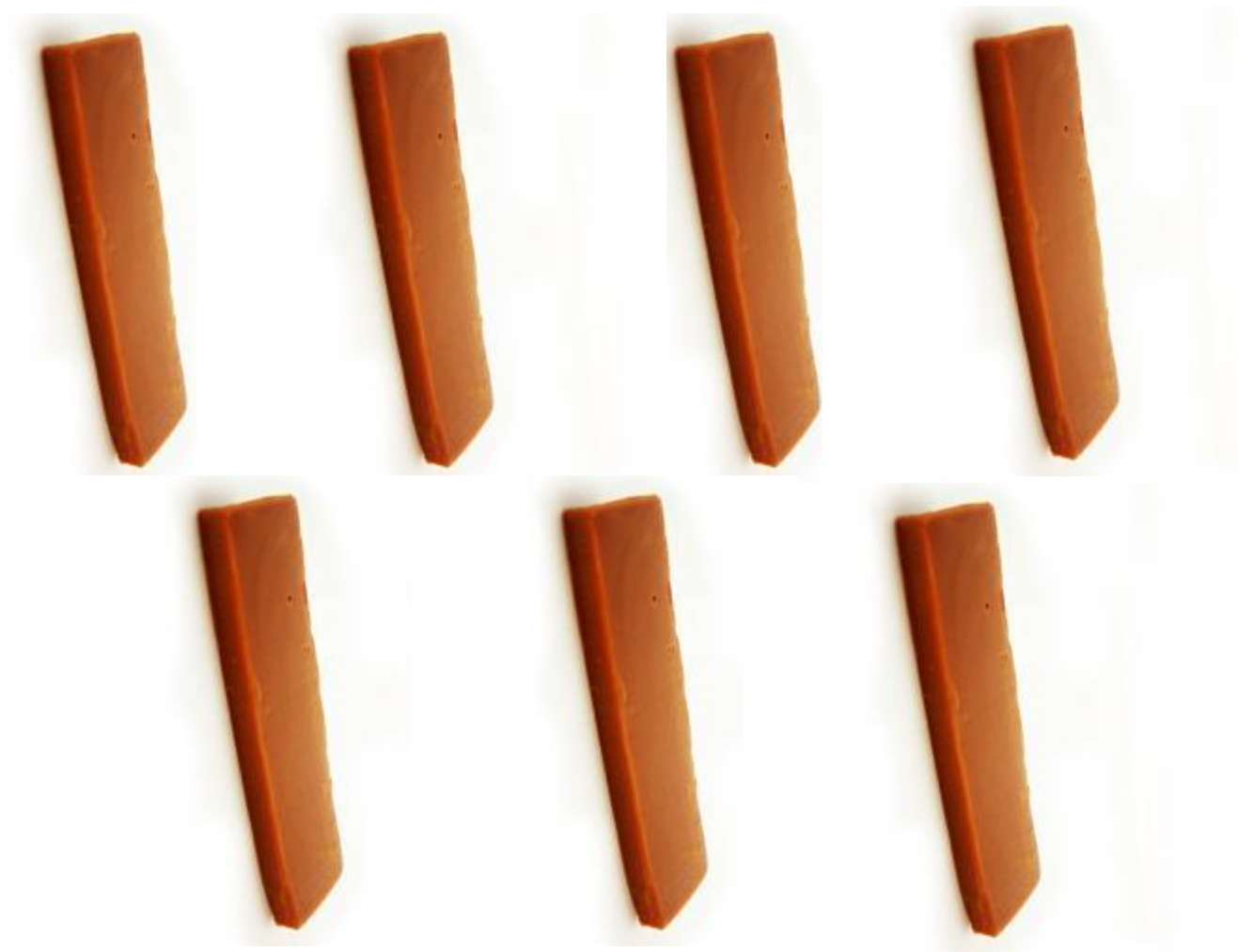
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Five people share these four candy bars.



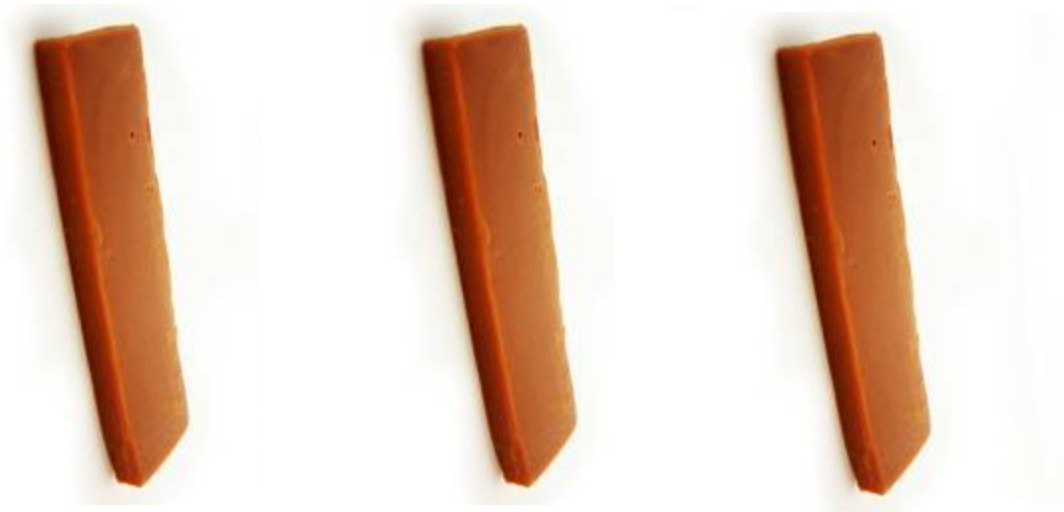
Eight people share these seven candy bars.

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Five people share these three candy bars.



Constructing Task: Sharing Candy Bars Differently

Adapted from Contexts for Learning Mathematics Fractions, Decimals, and Percents by Fosnot, Catherine Twomey et.al.

This task continues where the previous task left off. Many students may be curious about whether or not there is a way to share the candy bars equally before you even introduce this part of the lesson. If this is the case, let them think that they're driving the lesson. It will probably promote more inquiry in later tasks. The lesson begins with a quick series of computation problems that promote partial products with whole numbers and fractions.

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.3 Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret $3/4$ as the result of dividing 3 by 4, noting that $3/4$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size $3/4$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?*

MCC5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)*

MCC5.NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem. (for descriptors of standard cluster, see beginning of unit)

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

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- How can we describe how much someone gets in a fair-share situation if the fair share is less than 1?
- How can we describe how much someone gets in a fair-share situation if the fair share is between two whole numbers?
- How can fractions be used to describe fair shares?
- How does the size of the whole determine the size of the fraction?

MATERIALS

- Copy of Sharing Candy Bars task (1 set of four pages per pair or small group)
- Pencil
- Accessible manipulatives

GROUPING

Pair/Small Group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments: This task was developed from Contexts for Learning Mathematics, by Fosnot and Jacob. A recording sheet is provided, but is not necessary for this task, especially if students are using a math journal or learning log. Students should draw representations of their mathematical thinking as well as use words and numbers to explain their thinking for three reasons:

SMP2. Reason abstractly and quantitatively.

SMP3. Construct viable arguments and critique the reasoning of others.

SMP4. Model with mathematics.

Students should be allowed to draw representations of their thinking. This allows them to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

Students engaging in this task have an understanding of fair shares. If students lack this understanding, they will benefit from the previous task, as well as activities from Teaching Student Centered Mathematics, by John Van de Walle, pg. 136.

Teacher Notes:

Have the computation discussion with students and draw empty arrays to show their thinking. See below.

10 x 128

2 x 128

128 x 12

33 x 10

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33 x 9
3 x 1/5
7 x 1/8
3 x 1/4
4 x 1/5

For the problem 128×2 , if a student said, “I did 125×2 and got 150, then did 3×2 and got 6. $150 + 6 = 156$.” You would draw something similar to the open array below.

	125	3
2	250	6

The same thing would be true for the computation discussions involving fractions:
For the problem $3 \times \frac{1}{4}$, if a student said, “I did $\frac{1}{4}$ three times and got $\frac{3}{4}$, you might draw something like the following:

	$\frac{1}{4}$	
3		

Review what was learned from the previous task. Give time for students to make sense and comments on others’ work.

Introduce the problem and be sure everyone is clear with the context. Use the pictures from the last task to include at the end of this task to help develop this context.

Facilitate a preliminary discussion with the class, before students begin to work on the problem. Allow students to share their initial thoughts, then ask them to work in pairs to investigate the following:

Was the distribution of candy bars fair – did everyone in the class get the same amount?

How much of a candy bar did each person get, assuming the pieces were cut equally?

Ask students to investigate if it would be fairer if groups the first and third groups combined and shared their candy bars, and if the second and fourth groups combined and shared their candy bars. Place the papers from the last task together as stated above.

Encourage student struggles to become exciting challenges! As students cut up the candy bars, you may notice them:

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Cutting halves and using landmark fractions.

For groups 2 and 4, there are 7 candy bars for 10 people. Students might cut 5 candy bars in half and cut the remaining candy bars into fifths, resulting in $\frac{1}{2} + \frac{1}{5}$ per person.

For groups 1 and 3, there are 10 candy bars for 12 people. Similarly, students may cut 6 candy bars in halves and cut the remaining candy bars into thirds. This would give each person $\frac{1}{2} + \frac{1}{3}$ of a candy bar to each person.

Using the idea of division represented as a fraction. Today they see that they have $\frac{7}{10}$ and $\frac{10}{12}$ to compare. They may not be able to use common denominators to compare, but they will have some of their own ways to compare and they should be encouraged to do this. For example, they may take the information from yesterday's lesson and decide to compare $\frac{3}{5}$ and $\frac{4}{5}$ to $\frac{7}{10}$. Using connecting cubes or other manipulatives, students should be given the chance to make sense of the mathematics within the context of this problem. They may notice that $\frac{4}{5}$ is the same as $\frac{8}{10}$, and $\frac{3}{5}$ is the same as $\frac{6}{10}$, so $\frac{7}{10}$ is right in the middle.

Using the long division algorithm to find a decimal quotient and then comparing. This strategy promotes nice equivalents for students to compare. It may be necessary to remind students who use this strategy that any decimals they find represent tenths.

It's possible that some students may begin to think of ratios such as $\frac{3\frac{1}{2}}{5}$

Do not discourage this, since it is mathematically true and is an equivalent relation. This kind of thinking should be supported, since it shows an ability to think flexibly and will help develop fraction sense.

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answer is correct?
- How far away from a whole is your fraction? How do you know?
- What if we said these pieces you've drawn right here were now halves instead of eighths? How would your answer change?
- Did you develop a shortcut to find your answers?
- Did you identify any patterns or rules? Explain!

After enough time has been devoted to the task, ask pairs of students to make posters to prepare for the closing of the lesson. Posters should be clear for others in the class to understand their thinking, but should not just be the figuring that was initially done copied over again. The posters should be clear and concise presentations of any important ideas and strategies students wish to present. The method they used to compare the situations and their justifications for why they think the combined group sharing is fairer (or not) should be included in their poster.

Some ideas to encourage discussion about in the presentations of student work:

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The size or amount of the whole matters
With unit fractions, the greater the denominator, the smaller the piece is
When naming the piece, the whole matters
As students share ideas, listen for important ideas that may be worth spending extra time discussing, such as:
How to compare fractions
Interesting ways to redistribute candy bars
How they know that when combining groups of candy bars (numerators) and groups of people (denominators), you get a fraction in between.
Look for:
Evidence of halves and unit fractions, and an understanding that the redistributing produces an amount in between.
Comparing fractions and realizing that redistributing produces a fraction in between the original two fractions.
Using division to produce decimals to compare the quantities.

Final thoughts:

This investigation is fairer than the first, but is still not fair. Some students still get more candy than others.

The investigation does not need to end here. In fact, students may wonder if it would be fairer to share the 17 candy bars together with all of the 22 students. It is worth the time to do so.

Emphasize to students that it would not be efficient to cut the candy bars into 22 little pieces. Ask students if $17/22$ is about $\frac{1}{2}$, $\frac{3}{4}$, or $\frac{2}{3}$? Where could one cut be made that would be a nice approximation?

Questions for Teacher Reflection

How did my students engage in the 8 mathematical practices today?

How effective was I in creating an environment where meaningful learning could take place?

How effective was my questioning today? Did I question too little or say too much?

Were manipulatives made accessible for students to work through the task?

One positive thing about today's lesson and one thing you will change.

The following are instructional guidelines for creating more, perhaps similar equal sharing problems for fifth grade students.

Instructional guidelines for Equal Sharing Problems and Introducing Fractions (from Extending Children's Mathematics, Fractions and Decimals, Empson, Susan B., and Levi, Linda)

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- Represent children's solutions with equations, with an emphasis on linking addition and multiplication and on equations that reflect a multiplicative understanding of fractions. For example, if students solved a problem about 8 children sharing 5 burgers you might write the following equations:
- $1/8 + 1/8 + 1/8 + 1/8 + 1/8 = 5/8$ ("Lura drew 5 hamburgers and gave each person and eighth of each hamburger. She put the pieces together and said that $1/8$ plus $1/8$ plus $1/8$ plus $1/8$ plus $1/8$ is $5/8$. Does this equation show what Lura did?")
- $5 \times 1/8 = 5/8$ ("Shelly drew 1 hamburger and split it into 8 pieces. She said that each person would get $1/8$ of this hamburger. The other hamburgers would look the same as this and she said 5 groups of $1/8$ is the same as $5/8$."
 - 5 divided by 8 is $5/8$ ("Krystal said that she knows that when 5 things are shared by 8 people, each person gets $5/8$."))
- Represent the word problem situation using equations.
 - 8 children are sharing 5 hamburgers equally. How much hamburger does one child get?
 - $5 \div 8 = \square$
 - $8 \times \square = 5$

DIFFERENTIATION

Extension

- Allow students to investigate other shares and sharers as identified above. To challenge students, especially with large numbers of sharers, insist that students represent their fractions in multiple ways. For example, our team of 100 5th grade students is sharing the challenge of running a 40 mile race for charity. How many miles is each student's responsibility? Students could shade in a 10x10 grid, show the fraction as $40/100$ and (0.40), then show it again as $4/10$ (0.4) and again as $2/5$.

Intervention

- Use smaller numbers of sharers. For example, give students one or two candy bars that have 2-3 sharers. The use of student created or commercial manipulatives, with teacher guidance and questioning, will help students develop the concept of fractions as division.

Technology

http://nlvm.usu.edu/en/nav/category_g_2_t_1.html the national library of virtual manipulatives has several activities for students to practice operations and understanding of fractions.

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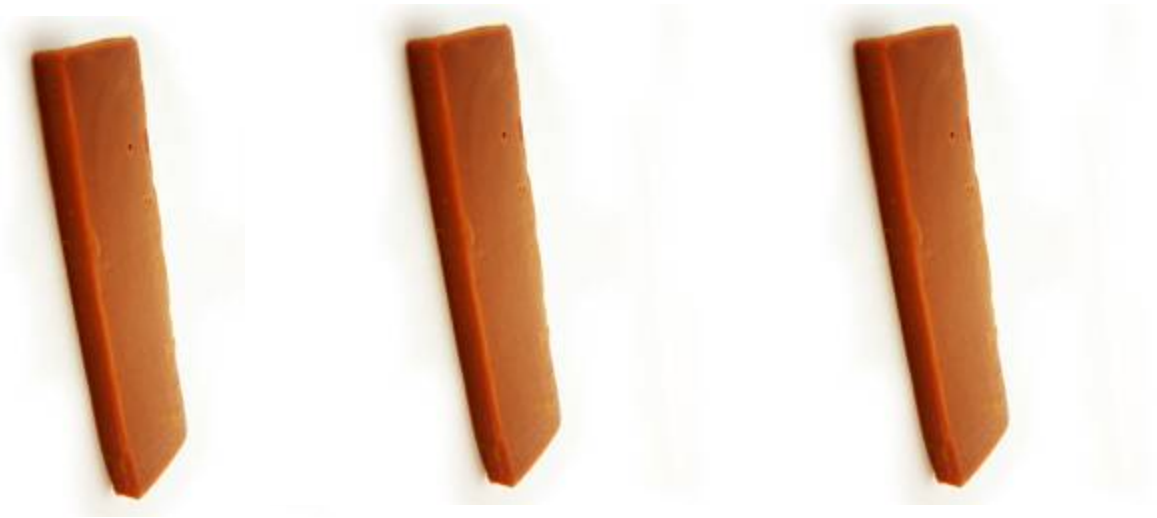
<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.

Sharing Candy Bars Differently

After looking at your first investigation, perhaps there is a way to make this sharing of candy bars more fair. Do you think it would be fairer if groups 1 and 3 combined and shared, and groups 2 and 4 combined and shared?

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Group 1. Four people share these three candy bars.



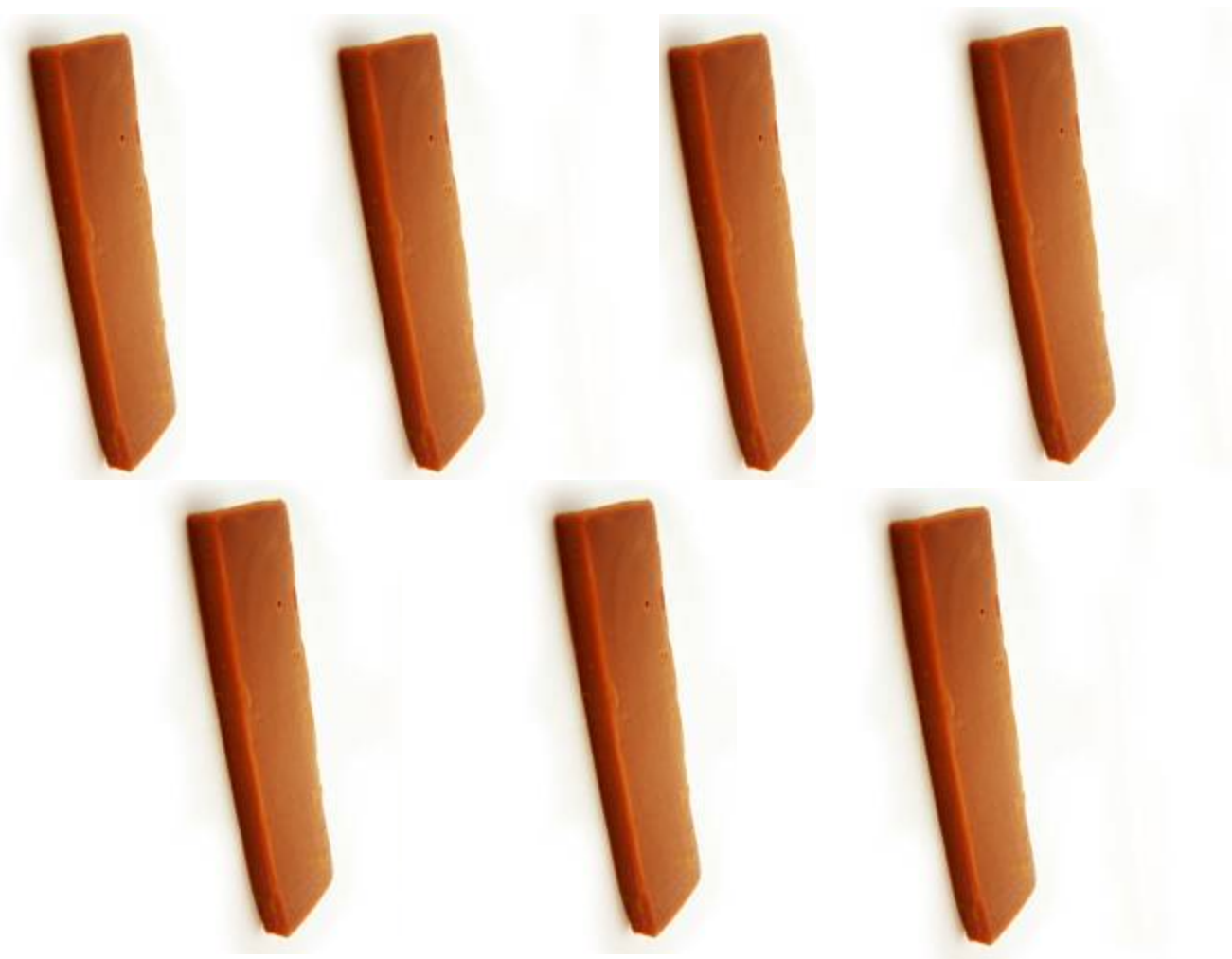
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Group 2. Five people share these four candy bars.



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Group 3. Eight people share these seven candy bars.



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Group 4. Five people share these three candy bars.



Performance Task: The Hiking Trail

Adapted from Contexts for Learning Mathematics Fractions, Decimals, and Percents by Fosnot, Catherine Twomey et.al.

This task develops the concept of equivalent fractions students will need to add fractions with unlike denominators later in the unit. The purpose of this task is to encourage student development of strategies to find equivalent fractions.

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.3 Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret $3/4$ as the result of dividing 3 by 4, noting that $3/4$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size $3/4$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?*

MCC5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)*

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can looking at patterns help us find equivalent fractions?
- How are equivalent fractions helpful when solving problems?
- How does the size of the whole determine the size of a fraction?
- How can we tell if some fractions are related?

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- How can learning about fractions that are related help us solve problems?

MATERIALS

- Copy of the Task The Hiking Trail (1 per pair of students or small group)
- Pencil
- Ruler (60 inch tape measure or yardstick)
- Accessible manipulatives

GROUPING

Pair/Small Group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments:

This task was adapted from *Contexts for Learning Mathematics Fractions, Decimals, and Percents* by Fosnot, Catherine Twomey et.al. A recording sheet is provided, but is not necessary for this task, especially if students are using a math journal or learning log. Students should draw representations of their mathematical thinking as well as use words and numbers to explain their thinking for three reasons:

SMP2. Reason abstractly and quantitatively.

SMP3. Construct viable arguments and critique the reasoning of others.

SMP4. Model with mathematics.

Students should be allowed to draw representations of their thinking. This allows them to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

This task was developed from *Contexts for Learning Mathematics*, by Fosnot and Jacob. Students engaging in this task have a deep understanding of fractions and the beginnings of fraction sense fostered in previous tasks. If students need additional support in developing this fraction sense, support students with activities from *Teaching Student-Centered Mathematics*, by John A Van de Walle and LouAnn Lovin., pgs. 144 – 146 (activities 5.6 – 5.10).

Teacher Notes:

Present one computation at a time and facilitate a discussion with students, asking them to find and explain the strategy they used to find:

100/2

100/4

200/4

200/8

400/16

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Introduce the problem and be sure everyone is clear with the context. Let students know that they will be designing a hiking trail for a four day Hike-a-thon. The trail is 6.0 km and is in the GA Mountains. The committee has decided what kind of informational markers and how often they should be placed. Your task is to figure out where to put informational markers along the way.

- A Camping area and Food Wagons should be at each fourth of the trail.
- Resting Points should be at every eighth of the trail.
- Water Stations should be at every tenth of the trail.
- Juice and Snack Tables should be at every fifth of the trail.
- Recycling and Trash Bins should be placed at every marker
- Kilometer Markers should be placed along the trail, so that hikers know how much of the course they've completed. These markers should be placed at every twelfth, sixth, and half of the course, as well as at all of the other locations above. These markers should show how many kilometers have been completed.

Give pairs of students sixty inch measuring tapes or yard sticks. Have the pairs draw a sixty inch hiking trail on some butcher paper.

Students may use a variety of strategies including, but not limited to:

- Halving. They may take half of the halves to find fourths, and take half of the fourths to find eighths.
- Dividing by the denominator. Students may think of $1/5$ of $6.0 = 6.0/5$
- Adding parts. Students may think about $3/8$ as $1/8$ more than $2/8$.
- Use equivalence ideas developed in the ratio table task earlier. Students may say $6/8 = 3/4$ since $3 \times 2 = 6$ and $4 \times 2 = 8$

FORMATIVE ASSESSMENT QUESTIONS

- *How can you tell that your answer is correct?*
- *How do you know that marker goes there? Show me your thinking.*
- *How can you tell that your markers are in the correct place? Is there another way to think about this?*
- *Did you develop a shortcut to find your answers?*
- *Did you identify any patterns or rules? Explain what you have found!*

After enough time has been devoted to the task, hang the work around the room and have students taken some time to view and make comments on others' work. Students may ask questions, or make mathematical commentary on post-it notes and stick them to the work. Pay attention to students' talk and make note of what is discussed during this time as it may give you some ideas about who should share and in what order they should share.

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When students have finished the tour, come back to the large group and begin the closing of the lesson. The goal of this closing is to help students make generalizations about equivalent fractions. Help students reach this goal, not by telling, but by asking thought provoking questions about the work.

DIFFERENTIATION

Extension

- Students who are ready for an extension of this lesson can connect it to geography by using a map of the GA Mountains and using map/math skills to highlight a 6.0 km trail.

Intervention

- Students requiring intervention should have access to manipulatives and, like all other students, share their thinking. All misconceptions are potential learning points for all students. In addition, students requiring intervention should be given a distance of 60 km, rather than 6.0 km, to build their understanding of fractions of whole numbers without the potential decimal as a response. In the closing, the connection between 60 km and 6.0 km (as well as the solutions to the problem) should be made by students through careful teacher questioning.

Technology

<http://www.bbc.co.uk/schools/ks2bitesize/maths/number/> a lot of games and activities for students to use to practice working with fractions and decimals as well as whole numbers.

http://education.nationalgeographic.com/education/mapping/interactive-map/?ar_a=1 this is an interactive map where students can create a trail, with markers, in the mountains of Georgia.

<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.

Mich

The Hiking Trail

Let students know that they will be designing a hiking trail for a four day Hike-a-thon. The trail is 6.0 km and is in the GA Mountains. The committee has decided what kind of informational markers and stations are needed and how often they should be placed. Your task is to figure out where to put informational markers and stations along the way.



- A Camping area and Food Wagons should be at each fourth of the trail.
- Resting Points should be at every eighth of the trail.
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- Kilometer Markers should be placed along the trail, so that hikers know how much of the course they've completed. These markers should be placed at every twelfth, sixth, and half of the course, as well as at all of the other locations above. These markers should show how many kilometers have been completed.

Constructing Task: Fraction Addition and Subtraction

This task helps students develop the concept of addition with fractions using common and unlike denominators through the use of various manipulatives. It is important for students to solve multiple problems over time using concrete models and representing these models on paper. It is important for students to write the abstract fraction equations however students must be able to explain and justify their thinking through representations and models.

STANDARDS FOR MATHEMATICAL CONTENT

Cluster: Use equivalent fractions as a strategy to add and subtract fractions.

MCC5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, $2/3 + 5/4 = 8/12 + 15/12 = 23/12$. (In general, $a/b + c/d = (ad + bc)/bd$.)*

MCC5.NF.2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. *For example, recognize an incorrect result $2/5 + 1/2 = 3/7$, by observing that $3/7 < 1/2$.*

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can looking at patterns help us find equivalent fractions?
- How are equivalent fractions helpful when solving problems?
- How can a model help us make sense of a problem?
- How can making equivalent fractions and using models help us solve problems?
- When should we use models to solve problems with fractions?
- What connections can we make between the models and equations with fractions?

MATERIALS

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- Pencil
- Journal, Learning Log, Student Problem Solving Notebook, etc.
- Accessible manipulatives, rulers may be helpful in this task, but are not necessary.
- Copy of task.

GROUPING

Pair/Small Group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments:

The goal of this task is for students to make sense of a problem with unlike denominators, where addition is the operation to use. The difficult part for the teacher is to not give students an algorithm (find common denominators) before the task. It is much more beneficial for students to struggle with the idea of how to go about combining two fractions with unlike denominators. This constructive struggle is where the learning happens, but the teacher must provide facilitating questions at the end of the lesson to bring the students' own understanding to light. A student journal question, asking what students learned, or what they are still struggling with when adding fractions with unlike denominators, would make a good formative assessment and it would give students time to reflect on their own thinking (metacognition) and understanding.

BACKGROUND KNOWLEDGE

Students can use any representations they wish (SMP 5), but they will always use representations that are familiar to them. Pattern blocks make great fraction manipulatives, but they can be limiting since they imply part to whole more often than part to set (or group). It is necessary for students to have multiple models for fractions in order to facilitate flexibility in representations and computation.

Teacher Notes:

Part I

Cut a strip of paper, see fraction strips at the end of this task and identify/label this as the whole that students will use to complete the task. Cut about 5 more strips the same length. Present the students with the following equations and have them model the equation using blank fraction strips. Have students share their model.

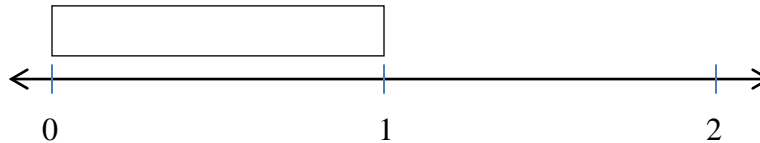
$$\begin{array}{l} \frac{1}{4} + \frac{1}{4} \\ \frac{1}{3} + \frac{1}{3} \\ \frac{2}{3} + \frac{2}{3} \end{array}$$

Students are guided to use the paper strips, fold, cut and join, but some students may already know what the answers are. Encourage students to prove they are correct with the models and see if they can name some of these fractions in other ways. What fractions are equivalent to $\frac{1}{2}$? (*show how you know with modeling*)

What fractions are equivalent to $\frac{4}{3}$? (*show how you know with modeling*)

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Use more examples if needed to increase students' understanding once students have created the strips, guide them to the next question which leads students to represent their models on a number line. Students may need guidance in creating the number line, locating where 1 would be, etc. Have students locate all of their leftover and newly created fractions on the number line. See below:



FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answers are correct?
- How do you know that your points on the number line are labeled correctly?
- What other names do you think there are for some of your points on the number line?
- Did you identify any patterns or rules for adding these kinds of fractions? Explain what you have found!

After enough time has been devoted to the task, group partners with other partners to make groups of 4-6 students. Appoint a facilitator to guide the group and make sure everyone shares their thinking. Pay attention to students' talk and make note of what is discussed during this time as it may give you some ideas about who should share and in what order they should share with the whole group.

When students have finished, come back to the large group and begin the closing of the lesson. The goal of this closing to help students make generalizations about adding fractions. Help students reach this goal, not by telling, but by asking thought provoking questions about the work and asking students to share in an order that moves from least efficient to most efficient, or mostly concrete to more representational and abstract.

Part II

Begin this lesson by reviewing the work from the previous lesson. Review any generalizations made and introduce the next part of the task.

Make sure everyone understands the context of the task. Let students know that the task they completed previously was a warm-up for the real task. In this task, student will be asked to do the same thing, but with fractions that are different. Show the fractions and equations:

Sam had $\frac{1}{2}$ of a chocolate bar and John gave him $\frac{1}{3}$ more of a chocolate bar. How much chocolate bar does he now have?

Sam had $\frac{2}{3}$ of a chocolate bar and John gave him $\frac{1}{2}$ more of a chocolate bar. How much chocolate bar does he now have?

Sam had $\frac{2}{3}$ of a chocolate bar and John gave him $\frac{1}{2}$ more of a chocolate bar. How much chocolate bar does he now have?

*****ALLOW TIME FOR A CONSTRUCTIVE STRUGGLE TO TAKE PLACE*****

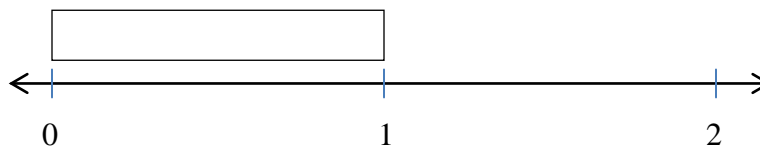
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Ask students what is different about these fractions/equations. Reflect back on the work from the last lesson again with questions like, “I remember when all we had was fourths: $\frac{1}{4}$ and $\frac{1}{4}$. That was TWO fourths. I wonder what we’ll have to do to combine fractions that are not alike. Any ideas? Brainstorm with your students and ask what they could do, since these fractions are not alike.

Students will not likely know any answers right away for this part, but having had the experience in part one, they will likely be successful with this. Students will likely be able to show fractions joined together as unlike denominators but unable to immediately identify the sum. Refer students to the previous lesson and allow them to share, again, what they learned about identifying equivalent fractions. Finding an equivalent fraction for the two parts combined can guide students to make meaningful connections and generalizations.

Students may ask for another strip to cut into smaller pieces. Encourage them to use the pieces they have to make what they need. This builds understandings of how fractions are related ($\frac{1}{2}$ of $\frac{1}{3}$ is $\frac{1}{6}$ or a $\frac{1}{2}$ piece cut in three makes 3 $\frac{1}{6}$ pieces) and helps build a fractional number sense. Experiences like this, with teacher guidance and questioning, will also build fluency with fraction computation.

Once students have created the strips for each equation, guide them to the next question which leads students to represent their models on a number line. Some students may still need guidance in creating the number line, locating where 1 would be, etc. See below:



Once students have completed their number line, have them label the point with an equation ($\frac{1}{2} + \frac{1}{3}$) as well as a fraction ($\frac{10}{12}$ or $\frac{5}{6}$).

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answers are correct?
- How do you know that your points on the number line are labeled correctly?
- How can we change these problems into ones just like the easy ones we did in the last task?
- Is there one fraction name for your equation points on the number line?
- Did you identify any patterns or rules for adding these kinds of fractions? Explain what you have found!

After enough time has been devoted to the task, group partners with other partners to make groups of 4-6 students. Appoint a facilitator to guide the group and make sure everyone shares their thinking. Pay attention to students’ talk and make note of what is discussed during this

time as it may give you some ideas about who should share and in what order they should share with the whole group.

When students have finished, come back to the large group and begin the closing of the lesson. The goal of this closing to help students make generalizations about adding fractions. Help students reach this goal, not by telling, but by asking thought provoking questions about the work and asking students to share in an order that moves from least efficient to most efficient, or mostly concrete to more representational.

DIFFERENTIATION

- **Extension**

Students needing an extension should be given opportunities to investigate addition with fractions with different denominators. This is what they will do in part II, but simple problems with a context should be used and can be found in Teaching Student Centered Mathematics Vol. 2, Grades 3-5, by John A. Van de Walle on pg 162. Samples of possible student representations can also be found on pg 163.

- **Intervention**

Students requiring intervention should use manipulatives and talk their way through the problem with teacher support and questioning.

Technology

<http://www.bbc.co.uk/schools/ks2bitesize/maths/number/> a lot of games and activities for students to use to practice working with fractions and decimals as well as whole numbers.

<http://www.counton.org/games/map-fractions/racing/> this is an interactive board game where players race bikes on a game board by adding fractions with like denominators.

<http://www.counton.org/games/map-fractions/frosty/> this is an interactive three across board game where players add fractions with like and unlike denominators and place a virtual counter on the sum. The first to get three in a row wins the game.

<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.

Fraction Addition and Subtraction

Part I

1. Cut out a strip of paper, and label it "1 whole." Cut 4 or 5 more of these same size strips. Fold, cut, and join the strips to create new strips that are the following lengths:

$$\frac{1}{4} + \frac{1}{4}$$

$$\frac{1}{3} + \frac{1}{3}$$

$$\frac{2}{3} + \frac{2}{3}$$

2. Use the strips you made in step 1, with diagrams and number lines to help you explain how to add and subtract fractions like these.

Fraction Addition and Subtraction Part II

1. Cut out a strip of paper, and label it "1 whole." Cut 4 or 5 more of these same size strips. Fold, cut, and join the strips to create new strips that are the following lengths:

$$\frac{1}{2} + \frac{1}{3}$$

$$\frac{2}{3} - \frac{1}{2}$$

$$\frac{2}{3} + \frac{1}{2}$$

2. Use the strips you made in step 1, with diagrams and number lines to help you explain how to add and subtract fractions like these. How is adding (and subtracting) these kinds of fractions different than the fractions in Part I?

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Practice Task – Flip it Over

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.1 Use equivalent fractions as a strategy to add and subtract fractions.

Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, $2/3 + 5/4 = 8/12 + 15/12 = 23/12$. (In general, $a/b + c/d = ad + bc/bd$)*

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can fractions with different denominators be added together?
- What strategies can we use for adding and subtracting fractions with different denominators?
- What models can we use to help us add and subtract fractions with different denominators?
- What do equivalent fractions have to do with adding and subtracting fractions?

MATERIALS

- Game board
- Two counters per person
- Available manipulatives

GROUPING

Group/Partner Task

TASK DESCRIPTION, DEVELOPMENT, AND DISCUSSION

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This task was developed to help students develop and use relationships between certain fractions for fraction computation. It is designed to allow students to develop these relationships for fluency and understanding of fractional computation.

In this task students will play a game to see who can flip over their cards first. This game will allow students to use their fractional understandings and build their fractional computation strategies. Logical thinking and problem solving skills will begin to develop their game playing strategies, the more students play the game.

Comments

Multiple fraction models, in addition to those included in the task, should be made available to the students as support for those who need it. In addition, fractional number lines (or open number lines) could benefit many students with this task.

This task could be introduced in a small group or by playing with class as a whole using available technology. In addition, the teachers could role model with a student, or better yet have two students role model how to play for the rest of the class.

Before asking students to work on this task, be sure students are able to:

Use models to create equivalent fractions (see previous tasks and Teaching Student Centered Mathematics, volume 2, pg 155-156 (Slicing Squares)).

Understand that a whole can be written as a fraction with any number of parts as long as all of those parts are included to make the whole. For example, a whole can be cut into tenths. In order to have a whole, I need all ten tenths (10/10).

Be able to decompose fraction, for example $\frac{4}{4} = \frac{1}{2} + \frac{1}{2}$ or $\frac{1}{4} + \frac{3}{4}$

Task Directions

Students will follow directions below from the Create Three Game activity.

Play the game several times.

Keep track of computation strategies used (use models in explanations during the closing).

Keep track of game playing strategies used (if any develop this first time playing).

FORMATIVE ASSESSMENT QUESTIONS

- What fractions do you find easy to work with? Why?
- Which fraction do you like to spin? Why?
- What strategies do you use when playing this game?

Questions for Teacher Reflection

While planning the task:

What level of support do my struggling students need in order to be successful with this task?

In what way can I deepen the understanding of those students who are competent in this task?

Could this game be played again, or changed in any way?

During and after the students complete the task:

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Which students have developed a strategy based on fraction understandings of numerators and denominators?

Which students are becoming fluent in creating equivalent fractions when adding fractions?

Which students still prefer to use manipulatives and rely heavily on models?

Questions for Teacher Reflection

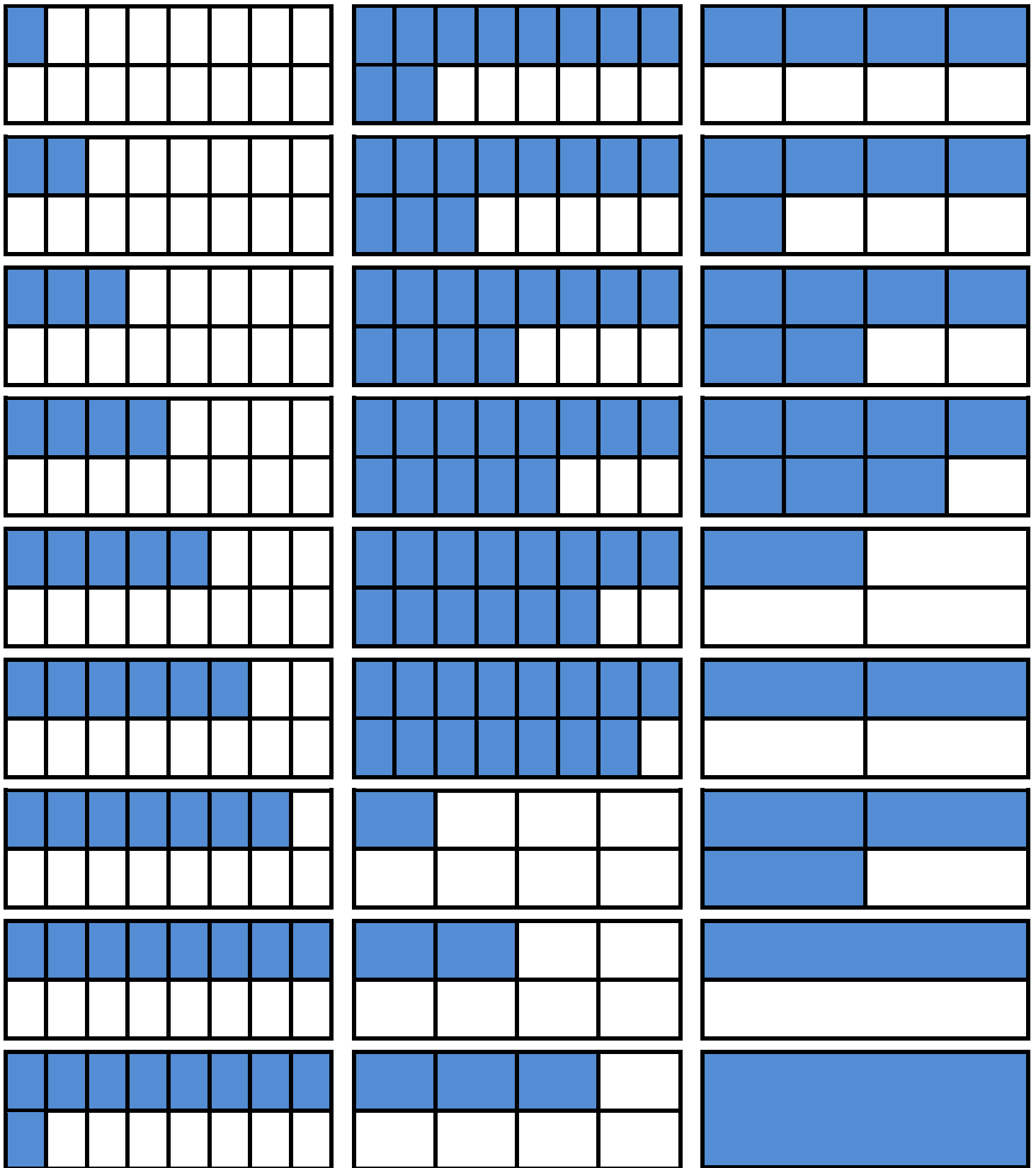
- How did my students engage in the 8 mathematical practices today?
- How effective was I in creating an environment where meaningful learning could take place?
- How effective was my questioning today? Did I question too little or say too much?
- Were manipulatives made accessible for students to work through the task?
- One positive thing about today's lesson and one thing you will change?

Technology

<http://www.counton.org/games/map-fractions/racing/> this is an interactive board game where players race bikes on a game board by adding fractions with like denominators.

<http://www.counton.org/games/map-fractions/frosty/> this is an interactive three across board game where players add fractions with like and unlike denominators and place a virtual counter on the sum. The first to get three in a row wins the game.

<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.



$\frac{2}{16}$	$\frac{3}{16}$	$\frac{4}{16}$
$\frac{5}{16}$	$\frac{6}{16}$	$\frac{7}{16}$
$\frac{8}{16}$	$\frac{9}{16}$	$\frac{10}{16}$
$\frac{11}{16}$	$\frac{12}{16}$	$\frac{13}{16}$
$\frac{14}{16}$	$\frac{15}{16}$	$\frac{16}{16}$
$\frac{1}{8}$	$\frac{2}{8}$	$\frac{3}{8}$

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$\frac{5}{8}$	$\frac{6}{8}$	$\frac{7}{8}$
$\frac{2}{4}$	$\frac{3}{4}$	$\frac{17}{16}$
$\frac{9}{8}$	$\frac{5}{4}$	$\frac{3}{2}$
$\frac{3}{8}$	$\frac{4}{8}$	$\frac{5}{8}$
$\frac{6}{8}$	$\frac{7}{8}$	

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Fraction Operation Cards

$+ \frac{1}{16}$	$+ \frac{3}{16}$	$+ \frac{5}{16}$
$+ \frac{1}{8}$	$+ \frac{3}{8}$	$+ \frac{7}{16}$
$+ \frac{5}{8}$	$+ \frac{3}{4}$	$+ \frac{9}{16}$
$+ \frac{7}{8}$	$+ \frac{1}{4}$	$+ \frac{1}{2}$

Flip it Over

Materials: One set of Fraction Picture Cards (attached), One set of Fraction Cards (attached), One set of Fraction Operation Cards, (attached).

Players: two or four players

Directions:

Set up the game:

- Deal all of the fraction number cards evenly to each player.
- Everyone places their fraction number cards face-up in front of them.
- Place the fraction picture cards in a deck, face down, in the center of the playing area.
- Place the set of fraction operation cards loosely in the center of the playing area.
- Decide who plays first.

Playing the game:

- The first player takes the top fraction picture card from the deck in the center, then chooses 3 operation cards.
- Player one chooses one or more of the operation cards to add to the picture card to make a sum equal to one of their fraction number cards.
- If you have a number card that matches the sum, flip it over.
- Return the used operation cards and the picture card to the center.
- Player two takes the left over operation card(s) takes some more to have three operation cards, then chooses a picture card
- Player two chooses one or more of the operation cards to add to the picture card to make a sum equal to one of their fraction number cards.
- If you have a number card that matches the sum, flip it over.
- Play continues in this way for each player.
- The first player to flip over all of his or her cards wins.

Practice Task – Up and Down the Number Line

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.1 Use equivalent fractions as a strategy to add and subtract fractions.

Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, $2/3 + 5/4 = 8/12 + 15/12 = 23/12$. (In general, $a/b + c/d = ad + bc/bd$)*

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can fractions with different denominators be added together?
- What strategies can we use for adding and subtracting fractions with different denominators?
- What models can we use to help us add and subtract fractions with different denominators?
- What do equivalent fractions have to do with adding and subtracting fractions?

MATERIALS

- Game board
- Two counters per person
- Available manipulatives

GROUPING

Partner Task

TASK DESCRIPTION, DEVELOPMENT, AND DISCUSSION

This game was developed from a kindergarten counting game and adapted for use with fractions.

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In this task students spin a spinner to move their counters up and/or down the number line. The first to move to their side of the number line wins the game. This game will allow students to use their fractional understandings to add and subtract fractions, look for relationships between certain fractions, and as their fractional computation strategies develop, logical thinking and problem solving skills will begin to develop their game playing strategies.

Comments

Multiple fraction models should be made available to the students as support for students who need it. In addition, fractional number lines (other than the ones included with the task) could benefit many students with this task. Students could utilize blank (open) number lines as a strategy as well.

This task could be introduced in a small group or by playing with class as a whole using available technology. In addition, the teacher could role model with a student, or better yet have two students role model how to play for the rest of the class.

Before asking students to work on this task, be sure students are able to:

- Use models to create equivalent fractions (see previous tasks and Teaching Student Centered Mathematics, volume 2, pg 155-156 (Slicing Squares)).
- Understand that a whole can be written as a fraction with any number of parts as long as all of those parts are included to make the whole. For example, a whole can be cut into tenths. In order to have a whole, I need all ten tenths (10/10).
- Be able to decompose fraction, for example $\frac{4}{4} = \frac{1}{2} + \frac{1}{2}$ or $\frac{1}{4} + \frac{3}{4}$.

Task Directions

Students will follow directions below from the Create Three Game activity.

Play several rounds with each other.

Keep track of computation strategies used (use models in explanations during the closing).

Keep track of game playing strategies you think are helping you.

During and after the students complete the task:

Which students have developed a strategy based on fraction understandings of numerators and denominators?

Which students are becoming fluent in creating equivalent fractions when adding fractions?

Which students still prefer to use manipulatives and rely heavily on models?

FORMATIVE ASSESSMENT QUESTIONS

- What fraction would you like to spin first? Why?
- What strategies do you have for this game?
- If you could change the spinner, what fraction would you like to have on it?
- Do you notice any relationships between any of the fractions?
- Do you think other fractions may have similar relationships? What fractions might have this similar relationship? Explain.

Questions for Teacher Reflection

While planning the task:

What level of support do my struggling students need in order to be successful with this task?
In what way can I deepen the understanding of those students who are competent in this task?
Could this game be played again, or changed in any way?

After the lesson:

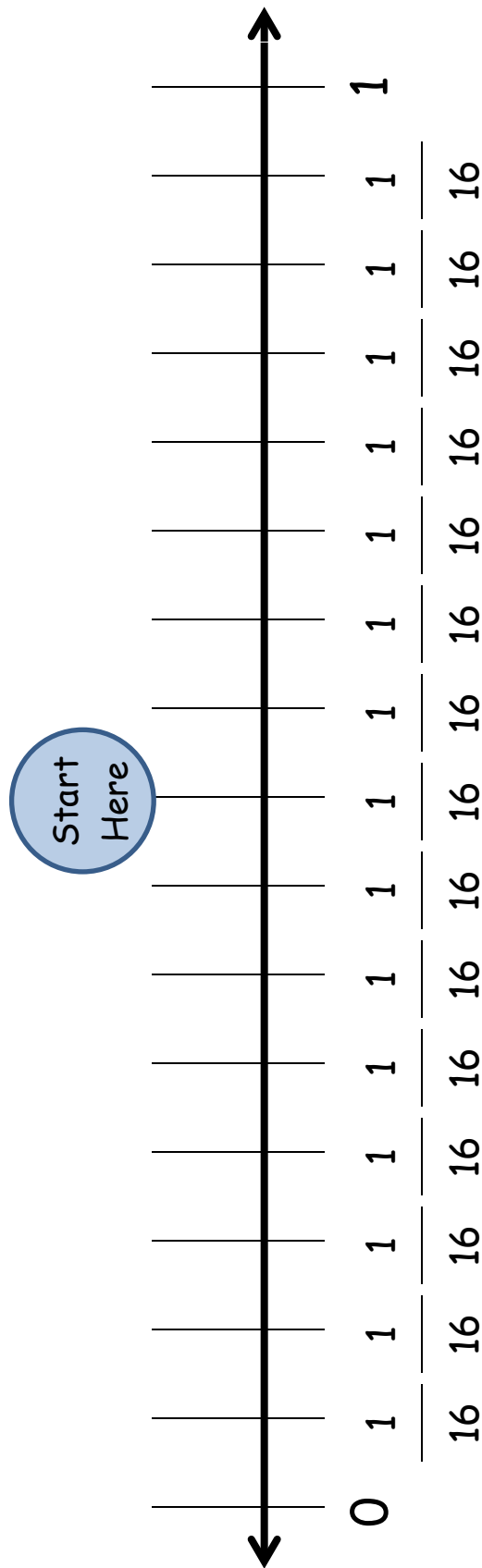
How did my students engage in the 8 mathematical practices today?
How effective was I in creating an environment where meaningful learning could take place?
How effective was my questioning today? Did I question too little or say too much?
Were manipulatives made accessible for students to work through the task?
One positive thing about today's lesson and one thing you will change.

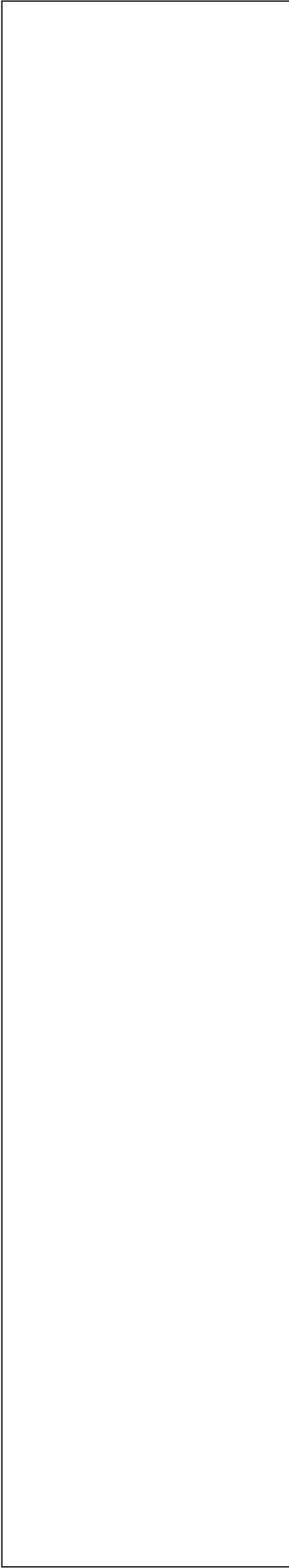
Technology

<http://www.counton.org/games/map-fractions/racing/> this is an interactive board game where players race bikes on a game board by adding fractions with like denominators.

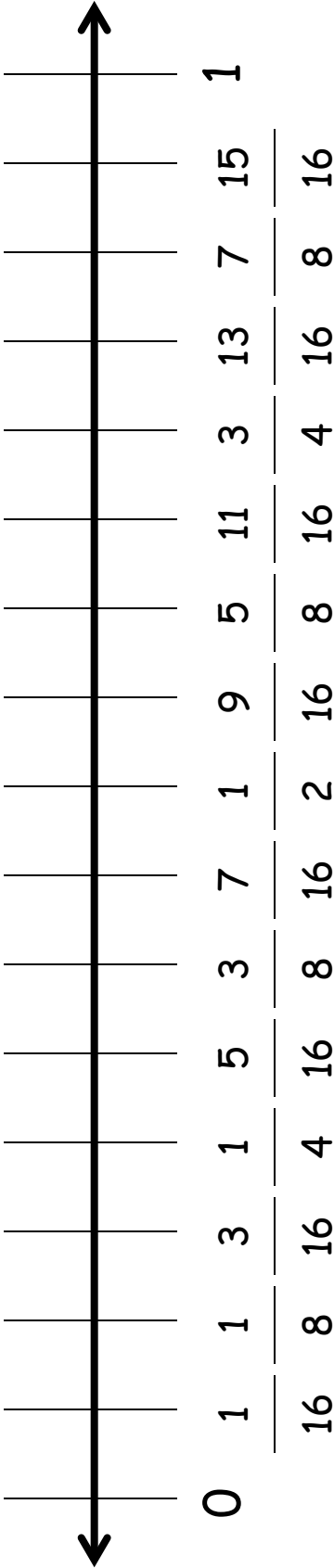
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<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.

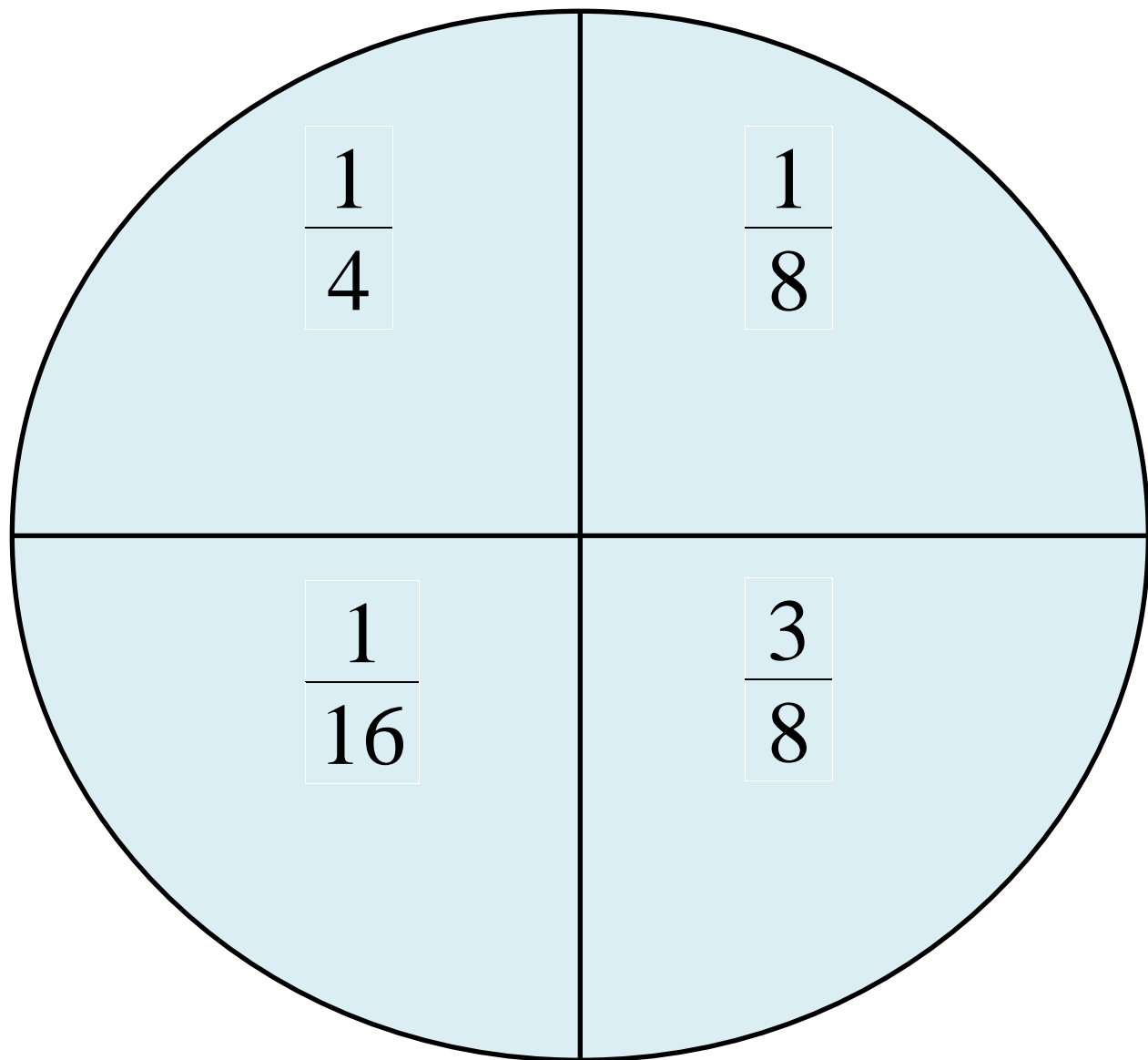




Start
Here



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Practice Task - Create Three

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.1 Use equivalent fractions as a strategy to add and subtract fractions.

Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, $2/3 + 5/4 = 8/12 + 15/12 = 23/12$. (In general, $a/b + c/d = ad + bc/bd$)*

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can fractions with different denominators be added together?
- What strategies can we use for adding and subtracting fractions with different denominators?
- What models can we use to help us add and subtract fractions with different denominators?
- What do equivalent fractions have to do with adding and subtracting fractions?

MATERIALS

- Game board
- Two counters per person
- Available manipulatives

GROUPING

Group/Partner Task

TASK DESCRIPTION, DEVELOPMENT, AND DISCUSSION

This game was adapted from www.nzmaths.co.nz.

In this task students will play a game to see who is the first to create 3 wholes on their number line and game board. This game will allow students to use their fractional understandings and as their

fractional computation strategies develop, logical thinking and problem solving skills will begin to develop their game playing strategies.

Comments

Multiple fraction models should be made available to the students as support for students who need it. In addition, fractional number lines (other than the ones included with the task) could benefit many students with this task. Students could utilize blank number lines as a strategy for keeping track of their score.

This task could be introduced in a small group or by playing with class as a whole using available technology. In addition, the teacher could model with a student, or better yet have two students role model how to play for the rest of the class.

Before asking students to work on this task, be sure students are able to:

Use models to create equivalent fractions (see previous tasks and Teaching Student Centered Mathematics, volume 2, pg 155-156 (Slicing Squares).

Understand that a whole can be written as a fraction with any number of parts as long as all of those parts are included to make the whole. For example, a whole can be cut into tenths. In order to have a whole, I need all ten tenths (10/10).

decompose fraction, for example $\frac{4}{4} = \frac{1}{2} + \frac{1}{2}$ or $\frac{1}{4} + \frac{3}{4}$

Task Directions

Students will follow directions below from the Create Three Game activity.

Play several rounds with each other.

Keep track of computation strategies used (use models in explanations during the closing).

Keep track of game playing strategies used (if any develop this first time playing).

FORMATIVE ASSESSMENT QUESTIONS

- What fractional do you like to start with? Why?
- What strategies do you have for this game?
- If you had to start on $\frac{5}{8}$, what would your first move be? Why?

Questions for Teacher Reflection

While planning the task:

What level of support do my struggling students need in order to be successful with this task?

In what way can I deepen the understanding of those students who are competent in this task?

Could this game be played again, or changed in any way?

During and after the students complete the task:

Which students have developed a strategy based on fraction understandings of numerators and denominators?

Which students are becoming fluent in creating equivalent fractions when adding fractions?

Which students still prefer to use manipulatives and rely heavily on models?

Questions for Teacher Reflection

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After the task:

- How did my students engage in the 8 mathematical practices today?
- How effective was I in creating an environment where meaningful learning could take place?
- How effective was my questioning today? Did I question too little or say too much?
- Were manipulatives made accessible for students to work through the task?
- One positive thing about today's lesson and one thing you will change.

Technology

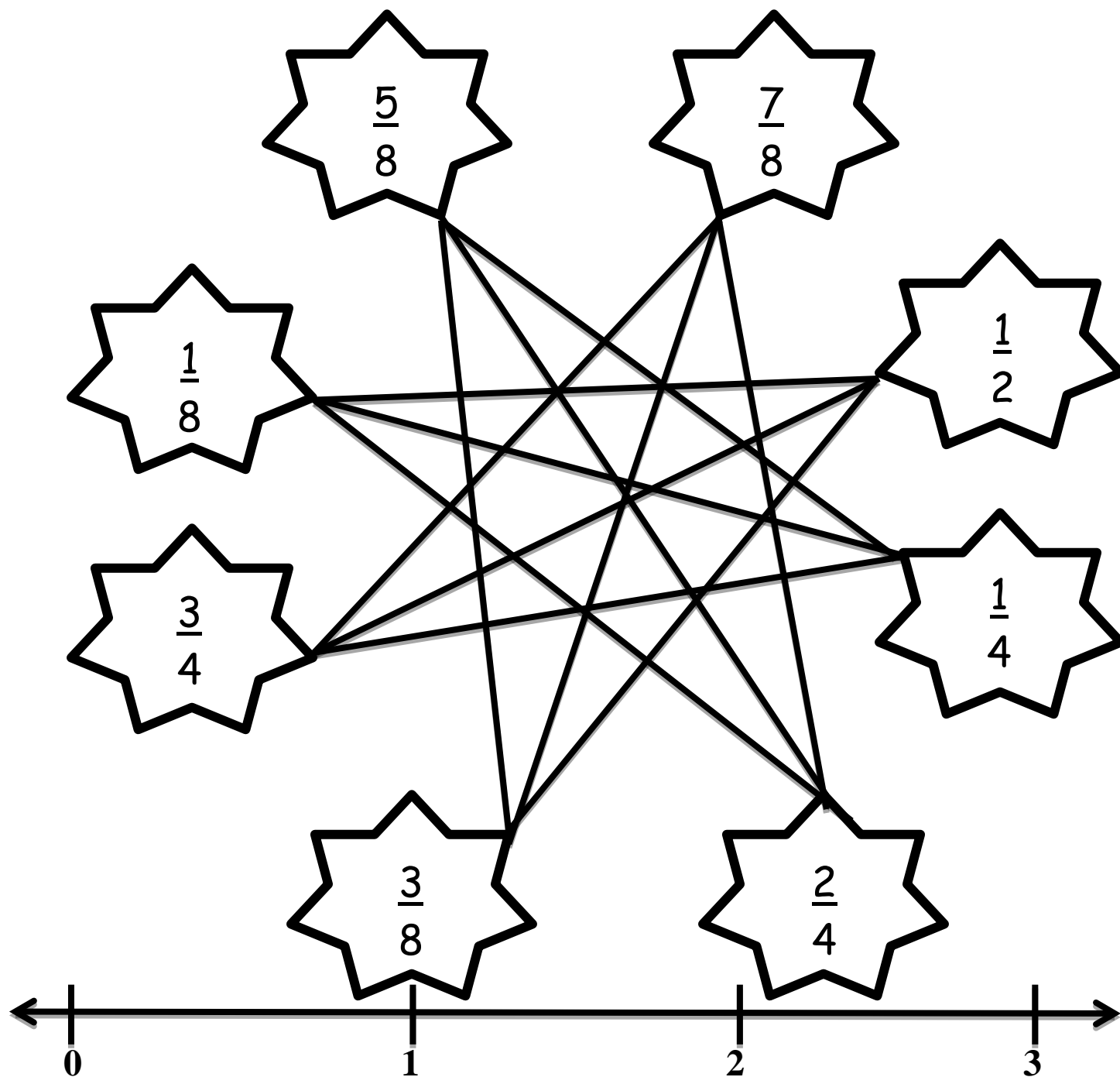
<http://www.counton.org/games/map-fractions/racing/> this is an interactive board game where players race bikes on a game board by adding fractions with like denominators.

<http://www.counton.org/games/map-fractions/frosty/> this is an interactive three across board game where players add fractions with like and unlike denominators and place a virtual counter on the sum. The first to get three in a row wins the game.

<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.

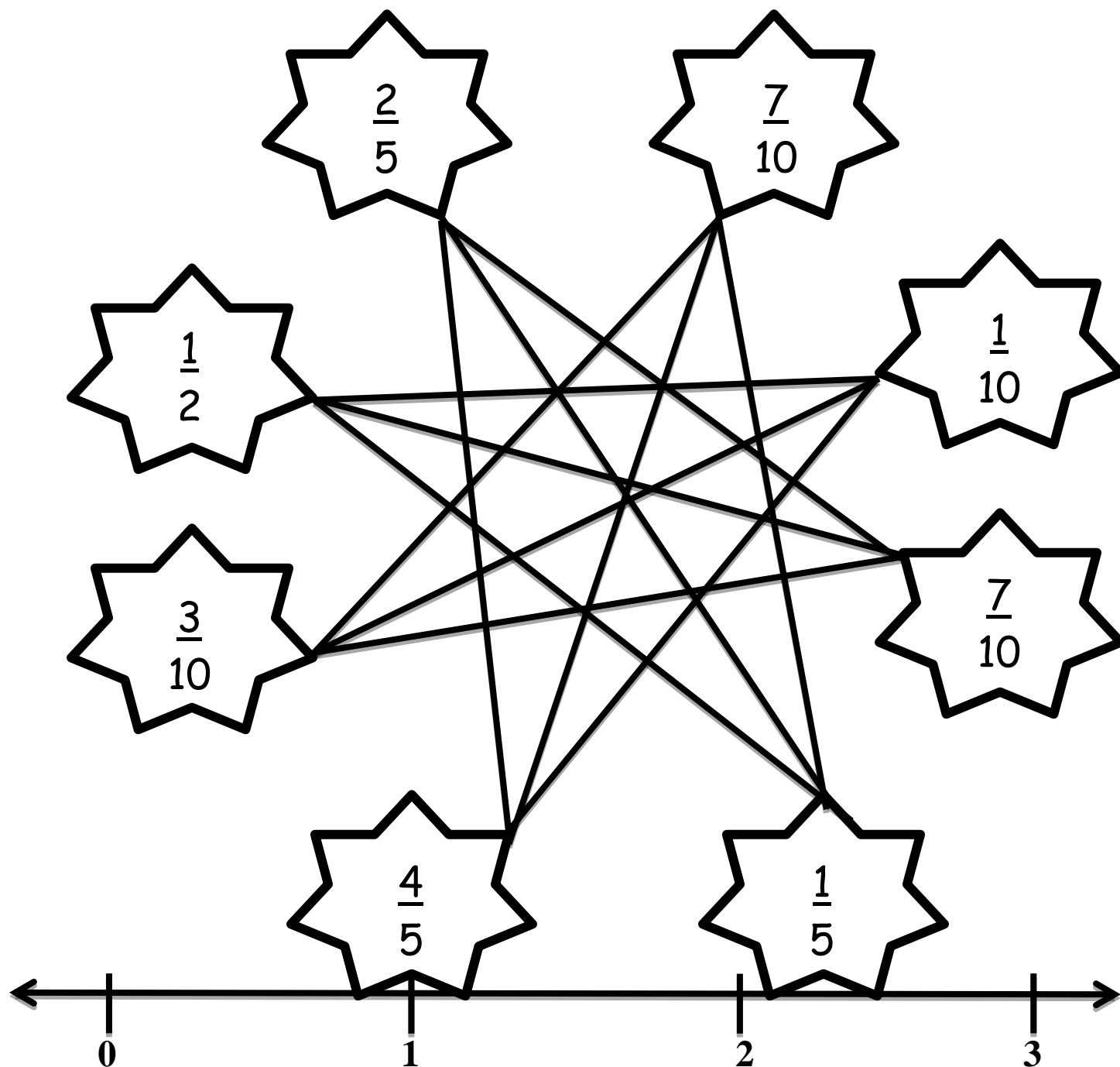
www.nzmaths.co.nz this site has some virtual problem solving games and others in the materials section under numeracy. There is a lot here, but it's all good, standards-based teaching strategies and tasks.

Create Three



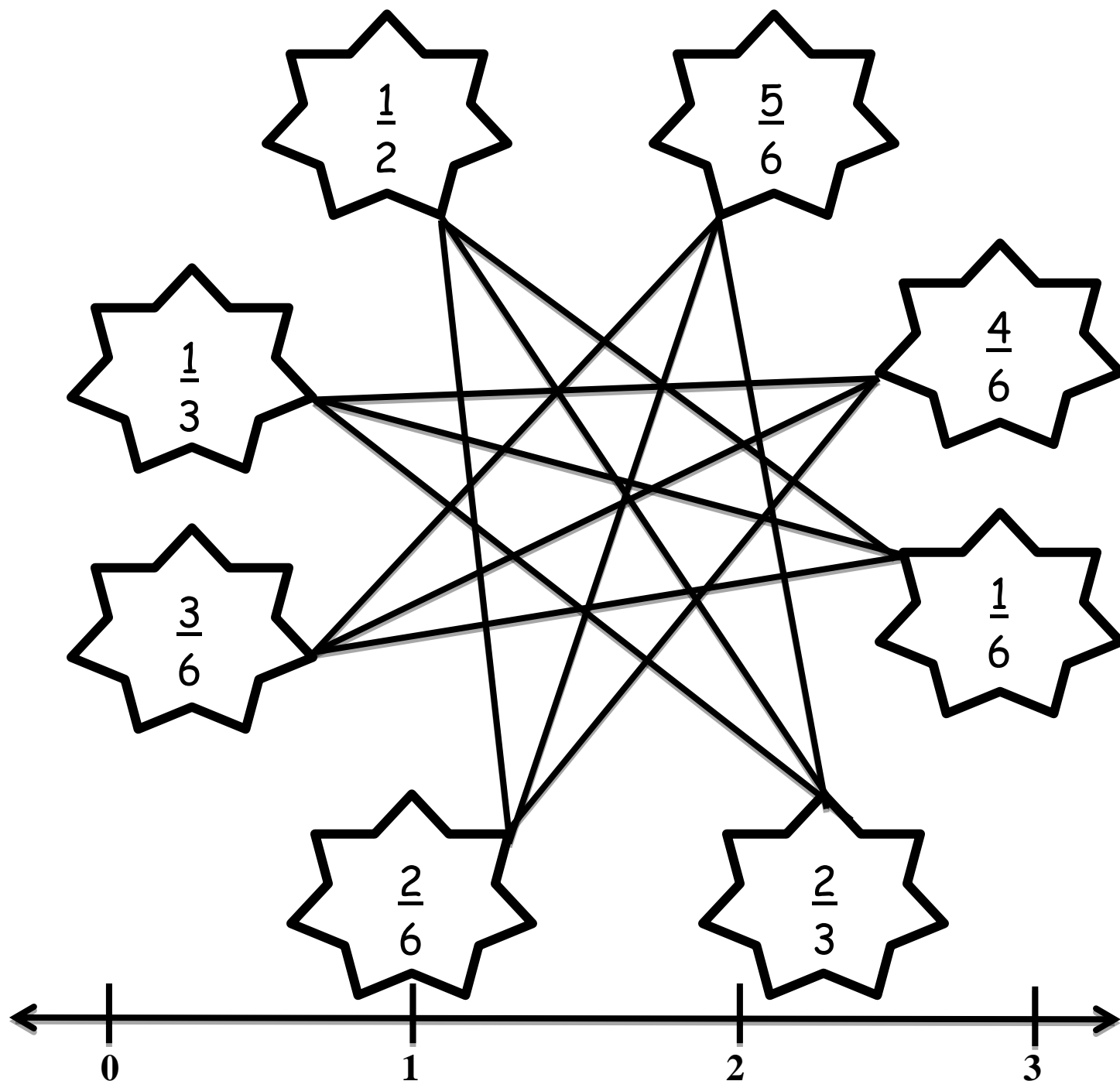
Play with a partner. Each player chooses a fraction to place their counter on. Take turns moving your counter to another fraction along the lines only. Add the new fraction to your total. The first player to make exactly three is the winner. Go over three and you lose the game. Players use an additional counter to keep a running total along the number line.

Create Three



Play with a partner. Each player chooses a fraction to place their counter on. Take turns moving your counter to another fraction along the lines only. Add the new fraction to your total. The first player to make exactly three is the winner. Go over three and you lose the game. Players use an additional counter to keep a running total along the number line.

Create Three



Play with a partner. Each player chooses a fraction to place their counter on. Take turns moving your counter to another fraction along the lines only. Add the new fraction to your total. The first player to make exactly three is the winner. Go over three and you lose the game. Players use an additional counter to keep a running total along the number line.

Performance Task: The Wishing Club

This task develops the concept addition of fractions using equivalent fractions with a variety of manipulatives. It is important for students to solve multiple problems over time using concrete models and representing these models on paper. With the representations, it is important for students to write the abstract fraction equations. Students then must explain their thinking, representations, and models.

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, $2/3 + 5/4 = 8/12 + 15/12 = 23/12$. (In general, $a/b + c/d = (ad + bc)/bd$.)*

MCC5.NF.2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. *For example, recognize an incorrect result $2/5 + 1/2 = 3/7$, by observing that $3/7 < 1/2$.*

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can looking at patterns help us find equivalent fractions?
- How are equivalent fractions helpful when solving problems?
- How can a model help us make sense of a problem?
- How can making equivalent fractions, and using models, help us solve problems?
- When should we use models to solve problems with fractions?
- What connections can we make between the models and equations with fractions?

MATERIALS

- Pencil
- Journal, Learning Log, Student Problem Solving Notebook, etc.
- Accessible manipulatives
- Copy of task.

GROUPING

Pair/Small Group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments:

This task was developed from the story *The Wishing Club*, by Donna Jo Napoli. A brief summary of Ms. Napoli's story is printed below, in case this wonderful book is not in your library.

The goal of this task is for students to make sense of and practice solving fraction problems with unlike denominators, where addition is the operation to use. The difficult part for the teacher is to not give students an algorithm (find common denominators) before the task. It is much more beneficial for students to struggle with the idea of how to go about combining two fractions with unlike denominators. This struggle is where the learning happens, but the teacher must provide facilitating questions at the end of the lesson to bring the students' own understanding to light. A student journal question, asking what students learned or what they are still struggling with when adding fractions with unlike denominators would make a good formative assessment and it would give students time to reflect on their own thinking (metacognition) and understanding.

BACKGROUND KNOWLEDGE

Students can use any representations they wish, but they will always use representations that are familiar to them. Pattern blocks make great fraction manipulatives, but they can be limiting since they imply part to whole more often than part to set (or group). It is necessary for students to have multiple models for fractions in order to facilitate flexibility in representations and computation.

Teacher Notes:

Part I

Read the story *The Wishing Club*, to your students, or if the book is not available, set up the problem by telling a story of four children who wished upon a star:

The first boy was 4 and he wished for a dollar, but only received a quarter. His 2 year old brother wished for a cookie, but only got half. Their 8 year old twin sisters received even smaller parts of their wishes.

(This may be a good time to set up a table with your students to see if they can find the pattern)

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<u>Age</u>	<u>part of wish</u>
2	$\frac{1}{2}$
4	$\frac{1}{4}$
8	?

Can they combine their parts to get a whole wish? Can they get a whole pet? They have to be careful and make sure they're correct (who wants half of a puppy?).

Show how you think they can get a full wish granted.

Allow pairs of (or small groups of) students to puzzle over the problem. Listen for students making sense of the context. Are students using manipulatives and/or making models. Are students using models that are easily broken into fractional parts?

Look for students who are relying heavily on models and manipulatives to solve the problem. Everyone should create a model for the problem as well as use equations, but during the closing part of the lesson, allow some of the students who relied heavily on manipulatives to share first. Allow students who used more abstract thinking (but who also model the problem and solution) to share last.

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answers are correct?
- How do you know that your points on the number line are labeled correctly?
- What other names do you think there are for some of your points on the number line?
- Did you identify any patterns or rules for adding these kinds of fractions? Explain what you have found!

After enough time has been devoted to the task, group partners with other partners to make groups of 4-6 students. Appoint a facilitator to guide the group and make sure everyone shares their thinking. Pay attention to students' talk and make note of what is discussed during this time as it may give you some ideas about who should share and in what order they should share with the whole group. When students have finished, come back to the large group and begin the closing of the lesson. The goal of this closing is to help students make further generalizations about adding fractions and to help them become more fluent. Help students reach this goal, not by telling, but by asking thought provoking questions about the work and asking students to share in an order that moves from least efficient to most efficient, or mostly concrete to more representational and abstract.

Part II

Begin this lesson by reviewing the work from the previous lesson. Review any generalizations made and introduce the next part of the task.

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Make sure everyone understands the context of the task. Let students know that the task they completed previously was a warm-up for the next task. In this task, students will be asked to find other ages of family members that would allow them to make a wish and get a complete pet.

Ask students to share initial thoughts about whether they think the children in their family could wish for and get a whole pet. Ask them to share how they know (some may say they are an only child, so they couldn't get a whole animal, others may point out that they are the youngest, so the pieces everyone else gets are smaller than theirs).

Give pairs of students the task for the day and ask them to find several different ages of children that would allow a wish for a whole pet.

FORMATIVE ASSESSMENT QUESTIONS

- *How can you tell that your answers are correct?*
- *What did you do to add the fractions together?*
- *Did you use any patterns or rules for adding these kinds of fractions? Explain what you have found!*

After enough time has been devoted to the task, Combine student pairs to make groups of 4-6 students. Appoint a facilitator to guide the group and make sure everyone shares their thinking. Pay attention to students' talk and make note of what is discussed during this time as it may give you some ideas about who should share and in what order they should share with the whole group.

When students have finished, come back to the large group and begin the closing of the lesson. The goal of this closing is to help students make generalizations about adding fractions. Help students reach this goal, not by telling, but by asking thought provoking questions about the work and asking students to share in an order that moves from least efficient to most efficient, or mostly concrete to more representational and abstract.

Questions for Teacher Reflection

- How did my students engage in the 8 mathematical practices today?
- How effective was I in creating an environment where meaningful learning could take place?
- How effective was my questioning today? Did I question too little or say too much?
- Were manipulatives made accessible for students to work through the task?
- One positive thing about today's lesson and one thing you will change.

Technology

<http://www.counton.org/games/map-fractions/racing/> this is an interactive board game where players race bikes on a game board by adding fractions with like denominators.

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<http://www.counton.org/games/map-fractions/frosty/> this is an interactive three across board game where players add fractions with like and unlike denominators and place a virtual counter on the sum. The first to get three in a row wins the game.

<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.

The Wishing Club - Part I

Is there a way for the two year old, the four year old and the twin eight year old sisters to wish for one whole animal? Show your mathematical thinking.

The Wishing Club - Part II

Can you think of any other combinations of ages in a family that would have allowed them to make a wish and get a whole pet? Show your mathematical thinking.

Constructing Task - Comparing MP3s

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.1 Use equivalent fractions as a strategy to add and subtract fractions.

Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, $\frac{2}{3} + \frac{5}{4} = \frac{8}{12} + \frac{15}{12} = \frac{23}{12}$. (In general, $\frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd}$.)*

MCC5.NF.2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. *For example, recognize an incorrect result $\frac{2}{5} + \frac{1}{2} = \frac{3}{7}$, by observing that $\frac{3}{7} < \frac{1}{2}$.*

MCC5.NF.3 Interpret a fraction as division of the numerator by the denominator ($\frac{a}{b} = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret $\frac{3}{4}$ as the result of dividing 3 by 4, noting that $\frac{3}{4}$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size $\frac{3}{4}$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?*

MCC5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

- a. Interpret the product $(\frac{a}{b}) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show $(\frac{2}{3}) \times 4 = \frac{8}{3}$, and create a story context for this equation. Do the same with $(\frac{2}{3}) \times (\frac{4}{5}) = \frac{8}{15}$. (In general, $(\frac{a}{b}) \times (\frac{c}{d}) = \frac{ac}{bd}$.)*
- b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.

MCC5.NF.5 Interpret multiplication as scaling (resizing), by:

- a. Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.
- b. Explaining why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence $\frac{a}{b} = \frac{n \times a}{n \times b}$ to the effect of multiplying $\frac{a}{b}$ by 1.

MCC5.NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can we model an area with fractional pieces?
- How can modeling an area help us with multiplying fractions?
- What does it mean to decompose fractions or mixed numbers?
- How can decomposing fractions or mixed numbers help us multiply fractions?
- How can decomposing fractions or mixed numbers help us model fraction multiplication?

MATERIALS

- Comparing MP3s Task
- Pencil, ruler
- Grid paper
- Accessible manipulatives

GROUPING

Pair/Small Group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION:

Comments:

This task was developed to give students a real world application of multiplying fractions that would be engaging. It also allows students to take the concept of arrays, which they should have worked with extensively in their study of multiplication, and apply this familiar concept to another area of multiplication – fractions.

Students should be allowed to draw representations of their thinking. This allows them to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

Students engaging in this task should be familiar with arrays and part-whole thinking as applied to multiplication. See Teaching Student Centered Mathematics, Vol. 2, Slicing Arrays Activity, pg. 66.

Teacher Notes:

Before the lesson, work with students on a computation discussion involving whole number multiplication. Use the following problems, one at a time, giving think time and time to share after each one. Discuss strategies and give students opportunities to make connections to other areas in mathematics.

10 x 16
5 x 16
16 x 1
16 x $\frac{1}{2}$
16 x $1\frac{1}{2}$
16 x $2\frac{1}{2}$
12 x $2\frac{1}{2}$

Introduce the problem and be sure everyone is clear with the context. You may wish to use the pictures included at the end of this task to help develop this context.

Facilitate a preliminary discussion with the class, before students get to working on the problem. Allow students to share their initial thoughts, then ask them to work in pairs to investigate the following:

One of the most popular mp3 players is Apple's iPod. However, companies such as Samsung and Microsoft are trying to take some business away from Apple with their own products – some of which can cost much less. As of right now, Apple's iPod is holding on to its share of the mp3 market, but some of the other mp3 players offer larger screens that might lure consumers from the Apple.

Apple wants our help to make a mock-up. They think if they can make the length of the new iPod Touch $1\frac{1}{4}$ times longer than it is now and the width $1\frac{1}{2}$ times longer than it is now, the iPod Touch will still be small enough to fit in a pocket or purse, but will have a screen size that is easier to use and work with and be large enough to compete with the largest touch screen mp3 player out there.

How much larger is each dimension of the prototype iPod than the original?

How much larger is the area of the prototype iPod than the original?

Samsung's model (Galaxy Player 5.0 with wi-fi) has dimensions of $3\frac{1}{10}$ x $5\frac{3}{5}$. Will Apple's new prototype be larger than Samsung's?

Possible struggles students may have can be turned into wonderful inquiries! As students investigate the screen areas, you may notice them:

Cutting each screen into familiar pieces first, such as wholes, then the fractional pieces. This strategy may lead them to an open array model.

Using multiplication of fractions algorithm. This strategy may promote discussion, so please allow students the freedom to make sense of this in the closing part of the lesson.

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answer is correct?
- How far away from a whole is your fractional area? How do you know?
- Did you develop a strategy to find your answers?
- Did you identify any patterns or rules? Explain!

After enough time has been devoted to the task, ask pairs of students to make posters to prepare for the closing of the lesson. Posters should be clear enough for others in the class to understand their thinking, but should not just be the figuring that was initially done copied over again. The posters should be clear and concise presentations of any important ideas and strategies students wish to present.

Some ideas to encourage discussion about in the presentations of student work:

Estimation, using just the whole number dimensions can help determine whether areas are in the ballpark.

How mixed numbers are decomposed can make a difference.

Students who use any algorithm should also make sense of the algorithm used with some kind of model.

DIFFERENTIATION

- **Extension**

Students should work on contextual problems such as those found in Teaching Student Centered Mathematics, by John Van de Walle, pgs 167-172. Possible student representations are also presented in these pages.

- **Intervention**

Students requiring intervention should also use contextual problems such as those found in Teaching Student Centered Mathematics, by John Van de Walle, pgs 167-172. Students should be talking their way through the problems with teacher support and questioning.

Technology

<http://www.bbc.co.uk/schools/ks2bitesize/maths/number/> games and activities for students to use for practice working with fractions and decimals, as well as whole numbers.

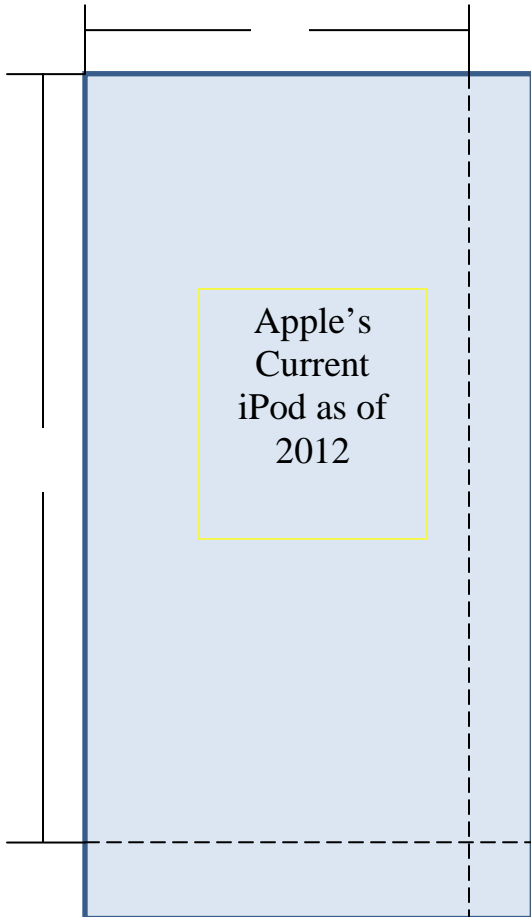
<http://www.counton.org/games/map-fractions/falling/> in this game, students find fractions of whole numbers to collect leaves falling from a tree. The player with the most leaves at the end of the game is the winner.

Constructing Task - Comparing MP3s

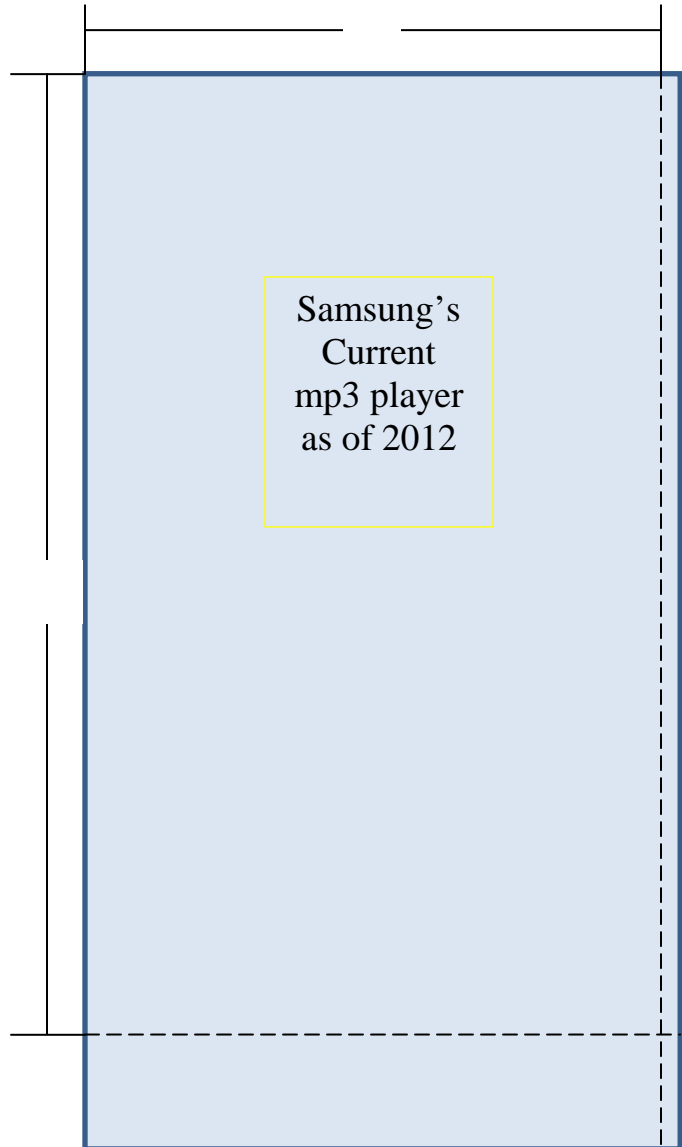
One of the most popular mp3 players is Apple's iPod. However, companies such as Samsung and Microsoft are trying to take some business away from Apple with their own products – some of which can cost much less. As of right now, Apple's iPod is holding on to its share of the mp3 market, but some of the other mp3 players offer larger screens that might lure consumers from the Apple.

Apple wants your help to make a mock-up. They think if they can make the length of the new iPod Touch $1\frac{1}{4}$ times longer than it is now and the width $1\frac{1}{2}$ times longer than it is now, the iPod Touch will still be small enough to fit in a pocket or purse, but will have a screen size that is easier to use and work with and be large enough to compete with the largest touch screen mp3 player out there.

Current iPod dimensions:
 $2\frac{1}{3} \times 4\frac{2}{5}$



Current Samsung Galaxy 5.0 dimensions:
 $3\frac{1}{10} \times 5\frac{3}{5}$



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What will the dimensions (length and width) of the new iPod Touch mock-up be, if the length and width are increased according to Apple's specifications?

Use grid paper, a pencil, and a ruler, or a drawing or word processing program to create your mock-up. Use the dimensions you found in step one to create the rectangle dimensions.

Find the area of each mp3 player including the new iPod Touch mock-up and make a decision based on your mathematics as to whether the new iPod Touch mock-up will be able to compete with Samsung's model. Be sure to include the areas of the screens, the differences in their dimensions, which one is larger and whether you think current iPod Touch users would like this change in size in your decision support statement.

Constructing Task – Measuring for a Pillow

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

- a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)*
- b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.

MCC5.NF.5 Interpret multiplication as scaling (resizing), by:

- a. Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.
- b. Explaining why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence $a/b = (n \times a)/(n \times b)$ to the effect of multiplying a/b by 1.

MCC5.NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.

(for descriptors of standard cluster, see beginning of unit)

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can comparing factor size to 1 help us predict what will happen to the product?
- How can we model an area with fractional pieces?

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- How can modeling an area help us with multiplying fractions?

MATERIALS

- Measuring for a Pillow Task
- Pencil, ruler
- Grid paper
- Fabric and thread or construction paper (optional)
- Accessible manipulatives

GROUPING

Pair/Individual

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION:

Comments:

This task was developed to give students a real world application of determining what will happen to products when one factor remains the same and the other changes. It is not necessary to complete the sewing aspect of this task, but if you do, it could elicit student inquiry into other mathematical investigations. This task is meant to involve students in a deeper investigation of the concept of the array with fractions.

Students should be allowed to draw representations of their thinking. Using grid paper may facilitate this. Creating these representations allows them to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

Students engaging in this task should be familiar with arrays and part-whole thinking as applied to multiplication. See Teaching Student Centered Mathematics, Vol. 2, Slicing Arrays Activity, pg. 66.

Teacher Notes:

Before beginning this task, have a computation discussion with your students using the following computations. It is important for students to have plenty of quiet think time for each individual computation as it is presented. Likewise, after the quiet think time, students should share their strategies before moving to the next problem.

$$10 \times 10$$

$$10 \times 5$$

$$10 \times 20$$

$$5 \times 20$$

After each is complete, if no student offers any thoughts about the products, provoke students to think about the products in each pair:

- Do you notice anything about the products in the pairs?
- Why do you think that’s happening?

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- What happened to the factors in each pair?
- Do you think this might happen all the time?

In your investigation over the next day or so, you may see and use this mathematical concept.

Part I

Introduce the task. Make sure students understand the concept of the task and what they are expected to do. Allow students to share ideas about the task with the group. Make sure students have construction paper (or fabric) and rulers to measure the correct dimensions. Sample intro idea:

You have been working with your book buddies in Kindergarten for several months now. It might be nice to give your book buddies a nice reading pillow for them to use while reading for the rest of the year. When thinking about pillows to lean against, a $12\frac{1}{2} \times 9$ inch pillow for seems like a good size for a Kindergarten student.

Questions for students to focus on as they investigate:

How big (what is the area of) this pillow?

Is this large enough?

Allow students to work in pairs to measure and cut the (fabric) construction paper to the proper dimensions and begin the task.

Listen to student thinking and provide support with thought provoking questions like the ones below. Students may use several strategies to solve this problem. Look for students who rely heavily on manipulatives. These students should share first in the closing part of the lesson. You may see students using some of these strategies:

After cutting the paper to the dimensions listed above, students may use 1 inch color tiles to tile the paper, noting that 9 tiles fit one dimension and $12\frac{1}{2}$ fit the other dimension. Students may note that 9×12 is 108 and 9 halves is $4\frac{1}{2}$, so the total is $112\frac{1}{2}$ square inches.

After cutting the paper to the dimensions listed, students may “cut” the paper with lines showing split arrays of 9×12 and $9 \times \frac{1}{2}$ or 9×10 , 9×2 , and $9 \times \frac{1}{2}$, then find the sums of these partial products.

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answer is correct?
- How do you know that mark goes there? Show me your thinking.
- How did you find the area of the pillow? Is there another way to think about this?
- Did you develop a shortcut to find your answers?
- What kind of representation will you use to show your thinking?
- Did you identify any patterns or rules? Explain what you have found!

After enough time has been devoted to the task, post the work around the room and have students take some time to view and make comments on others’ work. Students may ask questions, or make mathematical commentary on post-it notes and stick them to the work. Pay attention to students’

talk and make note of what is discussed during this time as it may give you some ideas about who should share and in what order they should share.

When students have finished the tour, come back to the large group and begin the closing of the lesson. The goal of this closing is to help students make connections about areas of rectangles with fractional dimensions. Help students reach this goal, not by telling, but by asking thought provoking questions about the work.

Questions for Teacher Reflection

- How did my students engage in the 8 mathematical practices today?
- How effective was I in creating an environment where meaningful learning could take place?
- How effective was my questioning today? Did I question too little or say too much?
- Were manipulatives made accessible for students to work through the task?
- One positive thing about today's lesson and one thing you will change.

Part II

Make sure students have completed and shared work from part I.

When beginning part II, make sure students understand the context of the problem and any new vocabulary is understood.

The problem in part II is that students think the pillow is much too small (even for kindergarten students), so they look to increase the pillow size (area).

As students are getting ready to begin this task, give them time to share ideas about how to approach the problem (strategies and general ideas). When they are ready, give them the task and have manipulatives available – including grid paper.

Questions for students to think about as they investigate part II:

Should the area be doubled or tripled? Show your mathematical thinking.

What should the dimensions be for your new pillow?

How do these new dimensions compare to the original pillow dimensions from part I?

Allow pairs of students to begin working on the task.

Listen to student thinking and provide support with thought provoking questions like the ones below. Students may use several strategies to solve this problem. Look for students who rely heavily on manipulatives. These students should share first in the closing part of the lesson. You may see students using some of these strategies:

Students may wish to cut and tape paper to new dimensions and tile with one inch tiles.

After cutting the paper to the dimensions listed, students may “cut” the paper with lines showing split arrays, then find the sums of these partial products.

FORMATIVE ASSESSMENT QUESTIONS

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- How can you tell that your answer is correct? Show me your thinking.
- How did you find the area of the pillow? Is there another way to think about this?
- Did you develop a shortcut to find your answers?
- What kind of representation will you use to show your thinking?
- Did you identify any patterns or rules? Explain what you have found!

After enough time has been devoted to the task, set the work around the room and have students take some time to view and make comments on others' work. Students may ask questions, or make mathematical commentary on post-it notes and stick them to the work. Pay attention to students' talk and make note of what is discussed during this time as it may give you some ideas about who should share and in what order they should share.

When students have finished the tour, come back to the large group and begin the closing of the lesson. The goal of this closing is to help students make connections about areas of rectangles with fractional dimensions. Help students reach this goal, not by telling, but by asking thought provoking questions about the work.

Questions for Teacher Reflection

How did my students engage in the 8 mathematical practices today?

How effective was I in creating an environment where meaningful learning could take place?

How effective was my questioning today? Did I question too little or say too much?

Were manipulatives made accessible for students to work through the task?

One positive thing about today's lesson and one thing you will change.

DIFFERENTIATION

- **Extension**

Students should work on contextual problems such as those found in Teaching Student Centered Mathematics, by John Van de Walle, pgs 167-172. Possible student representations are also presented in these pages.

- **Intervention**

Students requiring intervention should also use contextual problems such as those found in Teaching Student Centered Mathematics, by John Van de Walle, pgs 167-172. Students should be talking their way through the problems with teacher support and questioning.

TECHNOLOGY

<http://www.bbc.co.uk/schools/ks2bitesize/maths/number/> a lot of games and activities for students to use to practice working with fractions and decimals as well as whole numbers.

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<http://www.counton.org/games/map-fractions/falling/> in this game, students find fractions of whole numbers to collect leaves falling from a tree. The player with the most leaves at the end of the game is the winner.

http://nlvm.usu.edu/en/nav/category_g_2_t_1.html another activity from the national library of virtual manipulatives helps students see the multiplication of fractions as a familiar array.

Constructing Task – Measuring for a Pillow – Part I

You have been working with your book buddies in Kindergarten for several months now. It might be nice to give your book buddies a nice reading pillow for them to use while reading for the rest of the year. When thinking about pillows to lean against, a $12\frac{1}{2} \times 9$ inch pillow for seems like a good size for a Kindergarten student.

Questions:

How big (what is the area of) this pillow?

Is this large enough?

Constructing Task – Measuring for a Pillow – Part II

After cutting the fabric for the pillow, it doesn't look like the pillow will be large enough. You can't decide if you should double the area of the pillow, or triple it. Show the possible dimensions of pillows for each case. Show your mathematical thinking with sketches, words and numbers. Which do you think is a better fit for your book buddy? Explain.

Constructing Task – Reasoning with Fractions

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)*

MCC.NF.5 Interpret multiplication as scaling (resizing), by:

- a. Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.
- b. Explaining why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence $a/b = (n \times a)/(n \times b)$ to the effect of multiplying a/b by 1.

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can comparing factor size to 1 help us predict what will happen to the product?
- How can we model an area with fractional pieces?
- How can modeling an area help us with multiplying fractions?

MATERIALS

- Reasoning with Fractions Task
- Accessible manipulatives
- Grid Paper

GROUPING

Pair/Individual

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments:

This task was developed to give students a real world application of determining what will happen to products when one factor remains the same and the other changes. This task is meant to involve students in a deeper investigation of the concept of the array with fractions.

Students should be allowed to draw representations of their thinking. Using grid paper may facilitate this. Creating these representations allows them to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

Students engaging in this task should be familiar with arrays and part-whole thinking as applied to multiplication. See Teaching Student Centered Mathematics, Vol. 2, Slicing Arrays Activity, pg. 66.

Teacher Notes:

Before beginning this task, have a computation discussion with your students using the following computations. It is important for students to have plenty of quiet think time for each individual computation is presented. Likewise, after the quiet think time, students should share their strategies before moving to the next problem.

$$16 \times 1$$

$$\frac{1}{2} \times 16$$

$$1 \frac{1}{2} \times 16$$

Are any of the products smaller than the whole number factor?

Why do you think that’s happening?

Do you think this might happen all the time, even with mixed numbers?

In this task, you will investigate this mathematical concept.

Part I

Introduce the task. Make sure students understand the context of the task and what they are expected to do. Allow students to share ideas about the task with the group. Make sure students have materials necessary for investigating this task.

The problem here is not just to find answers to naked computation problems, but to explain why some of the products get smaller than one of the factors and other products become larger. Evidence must be presented as to why this happens in each case.

Allow students to work in pairs to answer the questions posed.

Listen to student thinking and provide support with thought provoking questions like the ones below.

Students may use several strategies to solve this problem.

Some students may use 1 inch color tiles, initially, but may run into trouble explaining fractions using these manipulatives. It is possible for students to use these manipulatives by assigning a fractional length to each tile. For example, students may decide that the length of each tile represents $\frac{1}{4}$, rather than 1. This presents its own challenges, but the struggle is where the learning happens.

Other students may use grid paper in the same manner presented above. A variety of grid sizes may be useful for this task.

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answer is correct?
- How does this explain what is happening here? Show me your thinking.
- What kind of representation will you use to show your thinking?
- Did you develop a shortcut to find your answers?
- Did you identify any patterns or rules? Explain what you have found!

After enough time has been devoted to the task, bring pairs of students together to share in groups of 4 to 6 students. As students share, listen for different explanations and look for different representations.

When students have finished the sharing, come back to the large group and begin the closing of the lesson. The goal of this closing is to help students make connections about areas of rectangles with fractional dimensions. Help students reach this goal, not by telling, but by asking thought provoking questions about the work.

Questions for Teacher Reflection

- How did my students engage in the 8 mathematical practices today?
- How effective was I in creating an environment where meaningful learning could take place?
- How effective was my questioning today? Did I question too little or say too much?
- Were manipulatives made accessible for students to work through the task?
- One positive thing about today's lesson and one thing you will change.

Constructing Task – Reasoning with Fractions

Below are several fraction multiplication problems out of context. The goal for each is to determine why the product is larger (or smaller) than the underlined factor. Use familiar manipulatives to investigate. Create a representation, along with words and numbers, to show your thinking.

$$1 \times \underline{18}$$

$$3 \times \underline{16}$$

$$\underline{14} \times \frac{1}{2}$$

$$\frac{1}{3} \times \underline{24}$$

$$1 \frac{1}{2} \times \underline{14}$$

$$2 \frac{1}{3} \times \underline{24}$$

Choose two from the last four problems and create a context for the each. Share your story problem with your partner.

Practice Task – Dividing with Unit Fractions

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.NF.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.¹

- a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients. *For example, create a story context for $(1/3) \div 4$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $(1/3) \div 4 = 1/12$ because $(1/12) \times 4 = 1/3$.*
- b. Interpret division of a whole number by a unit fraction, and compute such quotients. *For example, create a story context for $4 \div (1/5)$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $4 \div (1/5) = 20$ because $20 \times (1/5) = 4$.*
- c. Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem. *For example, how much chocolate will each person get if 3 people share $1/2$ lb of chocolate equally? How many $1/3$ -cup servings are in 2 cups of raisins?*

¹Students able to multiply fractions in general can develop strategies to divide fractions in general, by reasoning about the relationship between multiplication and division. But **division of a fraction by a fraction is not a requirement at this grade**

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- What does dividing a unit fraction by a whole number look like?
- What does dividing a whole number by a unit fraction look like?
- How can we model dividing a unit fraction by a whole number with manipulatives and diagrams?
- How can we model dividing a whole number by a unit fraction using manipulatives and diagrams?

MATERIALS

- Reasoning with Fractions Task
- Accessible manipulatives
- Grid Paper

GROUPING

Pair/Individual

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments:

This task was developed to give students an opportunity to make sense of division with fractional divisors and dividends. This task is meant to involve students in a deeper investigation of the concept of division in the context of unit fractions.

Students should be allowed to draw representations of their thinking. Using grid paper may facilitate this, but is not necessary. Students may wish to use other representations based on their own understandings. Creating these representations allows them to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

Students engaging in this task should be familiar with multiple fraction models, including but not limited to, fraction strips and circle fraction pieces, as well as less traditional fractional models such as color tiles, colored beads, and pattern blocks. The problems in this task were adapted from problems found in Teaching Student Centered Mathematics, volume 2, by John A. Van de Walle and LouAnn H. Lovin.

Teacher Notes:

Before beginning this task, have a computation discussion with your students using the following computations. It is important for students to have plenty of quiet think time for each individual computation is presented. Likewise, after the quiet think time, students should share their strategies before moving to the next problem.

What does it mean when you see the computation $16 \div 2$?

What do you think when you see the computation $16 \div \frac{1}{2}$?

What do you think of when you see the computation $\frac{1}{4} \div 6$?

Part I

Introduce the task. Make sure students understand the context of the task and what they are expected to do. Allow students to share ideas about the task with the group. Make sure students have materials necessary for investigating this task.

The problem here is not just to find answers to problems, but to explain why some of the quotients are larger than the divisor and dividend and some are smaller. Evidence must be presented for each using mathematical representations, words, and numbers.

Allow students to work in pairs to answer the questions posed.

Listen to student thinking and provide support with thought provoking questions such as those below.

Students may use several strategies to solve this problem.

Some students may use 1 inch color tiles to create the whole, but may run into trouble dividing by a unit fraction. It is possible for students to use these manipulatives by assigning a fractional length to each tile. For example, students may decide that the length of each tile represents $\frac{1}{4}$, rather than 1. This presents its own challenges, but the struggle is where the learning happens.

Other students may use grid paper in the same manner presented above. A variety of grid sizes may be useful for this task.

FORMATIVE ASSESSMENT QUESTIONS

- *How can you tell that your answer is correct?*
- *How does this explain what is happening here? Show me your thinking.*
- *What kind of representation will you use to show your thinking?*
- *Did you develop a shortcut to find your answers?*
- *Did you identify any patterns or rules? Explain what you have found!*

After enough time has been devoted to the task, bring pairs of students together to share in groups of 4 to 6 students. As students share, listen for different explanations and look for different representations.

When students have finished the sharing, come back to the large group and begin the closing of the lesson. The goal of this closing is to help students make connections about areas of rectangles with fractional dimensions. Help students reach this goal, not by telling, but by asking thought provoking questions about the work.

Questions for Teacher Reflection

- How did my students engage in the 8 mathematical practices today?
- How effective was I in creating an environment where meaningful learning could take place?
- How effective was my questioning today? Did I question too little or say too much?
- Were manipulatives made accessible for students to work through the task?
- One positive thing about today's lesson and one thing you will change.

DIFFERENTIATION

- **Extension**

Students should work on contextual problems such as those found in Teaching Student Centered Mathematics, by John Van de Walle, pgs 172-177. Possible student representations are also presented in these pages. The problems in this section go beyond what Common Core GPS require of 5th grade students, but it is worth a look. The fractions in the division problems presented can easily be changed to unit fractions without sacrificing the quality of the context. Likewise the mixed numbers can easily be changed to whole numbers.

- **Intervention**

Students requiring intervention should also use contextual problems such as those found in Teaching Student Centered Mathematics, by John Van de Walle, pgs 172-177. Students should talk their way through the problems with teacher support and questioning. The problems in this section go beyond what Common Core GPS require of 5th grade students, but it is worth a look. The fractions in the division problems presented can easily be changed to unit fractions without sacrificing the quality of the context. Likewise the mixed numbers can easily be changed to whole numbers.

Technology

http://www.learner.org/courses/learningmath/number/session9/part_a/area_division.html *This resource is for teacher understanding.* This is another lesson about division of fractions. This is where students will be in sixth grade, but this is a great resource to build teacher understanding of fraction division.

<http://www.k-5mathteachingresources.com/> this site offers simple contextual problems to use to extend and support students in their understanding of fraction computation and all problems are correlated to CCSS.

Culminating Task - Adjusting a Recipe

STANDARDS FOR MATHEMATICAL CONTENT

Use equivalent fractions as a strategy to add and subtract fractions.

MCC5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, $\frac{2}{3} + \frac{5}{4} = \frac{8}{12} + \frac{15}{12} = \frac{23}{12}$. (In general, $\frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd}$.)*

MCC5.NF.2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. *For example, recognize an incorrect result $\frac{2}{5} + \frac{1}{2} = \frac{3}{7}$, by observing that $\frac{3}{7} < \frac{1}{2}$.*

Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

MCC5.NF.3 Interpret a fraction as division of the numerator by the denominator ($\frac{a}{b} = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret $\frac{3}{4}$ as the result of dividing 3 by 4, noting that $\frac{3}{4}$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size $\frac{3}{4}$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?*

MCC5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

a. Interpret the product $(\frac{a}{b}) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show $(\frac{2}{3}) \times 4 = \frac{8}{3}$, and create a story context for this equation. Do the same with $(\frac{2}{3}) \times (\frac{4}{5}) = \frac{8}{15}$. (In general, $(\frac{a}{b}) \times (\frac{c}{d}) = \frac{ac}{bd}$.)*

b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.

MCC5.NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.

MCC5.NF.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.¹

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a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients. *For example, create a story context for $(1/3) \div 4$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $(1/3) \div 4 = 1/12$ because $(1/12) \times 4 = 1/3$.*

¹Students able to multiply fractions in general can develop strategies to divide fractions in general, by reasoning about the relationship between multiplication and division. But **division of a fraction by a fraction is not a requirement at this grade.**

b. Interpret division of a whole number by a unit fraction, and compute such quotients. *For example, create a story context for $4 \div (1/5)$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $4 \div (1/5) = 20$ because $20 \times (1/5) = 4$.*

c. Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem. *For example, how much chocolate will each person get if 3 people share $1/2$ lb of chocolate equally? How many $1/3$ -cup servings are in 2 cups of raisins?*

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

ESSENTIAL QUESTIONS

- How can looking at patterns help us find equivalent fractions?
- How are equivalent fractions helpful when solving problems?
- How can a model help us make sense of a problem?
- How can making equivalent fractions, and using models, help us solve problems?
- When should we use models to solve problems with fractions?
- What connections can we make between the models and equations with fractions?
- How can we model an area with fractional pieces?
- How can modeling an area help us with multiplying fractions?
- What does it mean to decompose fractions or mixed numbers?
- How can decomposing fractions or mixed numbers help us multiply fractions?
- How can decomposing fractions or mixed numbers help us model fraction multiplication?

MATERIALS

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- Adjusting a Recipe Task
- Pencil
- Accessible manipulatives

GROUPING

Pair/Small Group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments:

This task was developed as a means to assess students' understanding of operations on fractions in a real world context. It is designed to allow students the freedom to approach the problem using a variety of strategies and allows for many different solutions depending upon class size.

Students should be allowed to draw representations of their thinking. This allows them to “talk through” their process which in turn enables students the opportunity to attend to precision as they explain and reason mathematically.

BACKGROUND KNOWLEDGE

Students engaging in this task should have had multiple experiences with fraction addition and subtraction, multiplication and division of fractions by whole numbers and whole numbers by fractions similar to problems in previous tasks.

Teacher Notes:

Introduce the problem and be sure everyone is clear with the context. You may wish to use the sample cookie recipe (included at the end of this task) or find another recipe that has several fractions in it to use.

Facilitate a preliminary discussion with the class to make sure students understand all vocabulary as well as the context of the problem, before students get to work. After allowing students to share their initial thoughts, ask them to work in pairs or individually to investigate the following:

How would you rewrite the recipe for twice as many people? Show your mathematical thinking and explain how you know the rewritten recipe is correct.

How would you rewrite the recipe for half as many people? Show your mathematical thinking and explain how you know the rewritten recipe is correct.

Is it possible to adjust the recipe to make 30 cookies? What would you have to do to the measurements of each of the ingredients?

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Explain how you would adjust your recipe to feed everyone in our class (don't forget the teacher!) Is it possible to get the exact number of cookies for our class by adjusting the recipe? If not, adjust the recipe to get as close as possible (make sure everyone gets a cookie).

Possible struggles students may have can be turned into wonderful inquiries! As students investigate the screen areas, you may notice them:

Using array models or doubling ideas of multiplication to show how to double a recipe for some ingredients.

Using multiplication of fractions algorithm. This strategy may promote discussion, so please allow students the freedom to make sense of this in the closing part of the lesson.

Be on the lookout for students who, when working on halving the recipe, divide by $\frac{1}{2}$ rather than by 2. This may be a lack of understanding of the concept of division. Scaffolding the students' learning with thought provoking questions can help students strengthen their conceptual understanding.

FORMATIVE ASSESSMENT QUESTIONS

- How can you tell that your answer is correct?
- Does dividing by 2 (or $\frac{1}{2}$) help solve this problem? How do you know?
- Did you develop a strategy to find your answers?
- Did you identify any patterns or rules? Explain!

After enough time has been devoted to the task, ask students to make recipe cards to prepare for the closing of the lesson. Recipe cards should be clear enough for others in the class to understand their thinking, but should not just be the figuring that was initially done copied over again. The recipe cards should be clear and concise presentations of any important ideas and strategies students wish to present.

Some ideas to encourage discussion about in the presentations of student work:

Estimation, using whole number estimates can help determine whether measurements of ingredients are in the ballpark.

How fractions/mixed numbers are decomposed can make a difference.

Students who use any algorithm should also show understanding of the algorithm used with some kind of model.

Culminating Task - Adjusting a Recipe

Use the simple recipe for sugar cookies below or find another simple recipe in a recipe book or on the internet with at least four fractions in the ingredients list. Write the original recipe.

Rewrite the recipe for twice as many people. Show your mathematical thinking and show how you know the rewritten recipe is correct.

Rewrite the recipe for half as many people. Show your mathematical thinking and show how you know the rewritten recipe is correct.

Is it possible to adjust the recipe to make 30 cookies? What would you have to do to the measurements of each of the ingredients?

Explain how you would adjust your recipe to feed everyone in our class (don't forget the teacher!) Is it possible to get the exact number of cookies for our class by adjusting the recipe?

If not, adjust the recipe to get as close as possible (make sure everyone gets a cookie). How could we share the left-over cookie(s)?

How many batches of cookies would we need to bake if every student in the class receives the same number of cookies and no cookies were left over?

Simple Sugar Cookies (Makes 12)

Ingredients:

- 2/3 cup flour
- 1/4 teaspoon baking soda
- 1/8 teaspoon baking powder
- 1/4 cup butter, softened
- 3/4 cup white sugar
- 1 small egg
- 1/4 teaspoon vanilla extract

Directions:

Preheat oven to 375 degrees F (190 degrees C).

In a small bowl, stir together flour, baking soda, and baking powder. Set aside.

In a large bowl, cream together the butter and sugar until smooth. Beat in egg and vanilla.

Gradually blend in the dry ingredients. Roll rounded teaspoonfuls of dough into balls, and place onto ungreased cookie sheets. Bake 8 to 10 minutes in the preheated oven, or until golden.

Let stand on cookie sheet two minutes before removing to cool on wire racks.

Recipe adapted from <http://allrecipes.com/recipe/easy-sugar-cookies/>